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With METALLURGICAL SUPPLEMENT.

The Engineer.

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VOL. CXLII.—No. 3698] LONDON: FRIDAY EVENING, NOVEMBER 26, 1926 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. STEEL BOLTS and NUTS, 6in. to 20in. long, Fishbolt Quality.
2. TWO CRANES, ELECTRIC, TRAVELLING, JIB, 5-Ton and 7½-Ton Capacity.
3. Approx. 264,650 COPPER BONDS for TRACK RAILS.

Tenders due on the 3rd December, 1926, for No. 1, on the 17th December, 1926, for No. 2, and on the 4th January, 1927, for No. 3.
Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 4080

Assistant Architect Re- QUIRED by the GOVERNMENT of the GOLD COAST for two tours of 12 to 18 months' service, with possible extension. Salary £600, rising to £800 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, age 25 to 40, must have had experience of tropical work. Must be an A.R.I.B.A. or have higher qualifications.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/1c016. 4075

Assistant Engineer Re- QUIRED for the IRRIGATION SERVICE of IRAQ for two years' service on probation in the first instance, with prospects of extension for ten years. Free passages and liberal leave on full salary. Salary Rs. 650, rising to Rs. 800 a month by annual increments of Rs. 50. Candidates, preferably between 23-26 years of age, unmarried, should have passed the A.M.I.C.E. examination, have been educated at one of the leading Universities and have one or two years' practical experience since obtaining degrees.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14691. 4076

Assistant Engineer Re- QUIRED by the GOVERNMENT of KENYA COLONY for service in connection with the Mombasa Town Planning Scheme for a tour of from 20 to 30 months' service, with possible extension. Salary £650 a year. Free quarters and passages and liberal leave on full salary. Candidates, aged 30 to 38, must be A.M.I.C.E., or hold equivalent professional qualifications and have had thorough experience of municipal engineering and macadam roads.—Apply at once by letter, stating age, qualifications and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15029. 4093

Assistant Engineer Re- QUIRED for the NIGERIAN GOVERNMENT RAILWAY (Construction) for a tour of 12 to 18 months, with possible extension. Free passages and a commuted bush and travelling allowance of £9 a month whilst on duty in the Colony. Camp equipment provided. Outfit allowance of £60 on first appointment. Liberal leave on full salary. Salary £480 for the first three years of service, then £510, rising to £720 a year by annual increments of £30 and thence rising to £920 a year by annual increments of £40. Candidates must have passed examination to qualify for A.M.I.C.E. or hold equivalent professional qualifications and possess experience on Railway Location.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, clearly quoting M/14300. 4092

Assistant Structural ENGINEER REQUIRED by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT for two tours of from 12 to 18 months, with possible extension. Salary £600, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 40, must be accustomed to the preparation of reinforced concrete designs. Must be an A.M.I.C.E.—Apply at once by letter, stating age, qualifications and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15014. 4091

1. Vacancies Exist for CHIEF DESIGNER, DESIGNER, CHIEF TESTING ENGINEER, and FIRST ASSISTANT TESTING ENGINEER at the Admiralty Engineering Laboratory, West Drayton.

2. Candidates must have attained the age of 23 years and not more than 40 years of age on the 13th December, 1926. The latter age limit may be extended in certain cases as defined in the Regulations applicable to the posts.

3. Candidates for the positions of Chief Designer and Designer should have had considerable experience on the Drawing-office side of Experimental and Research Work in connection with Internal Combustion Engines and have had practical experience in a responsible engineering position for at least three years. Candidates for the positions of Chief Testing Engineer and First Assistant Testing Engineer should have had considerable experience in the erection and running of Heavy Oil Engines, should have a good understanding of machinery drawings and a knowledge of routine duties in connection with workshop administration and be of good physique.

4. The salary scales attaching to the posts are as follows :—

Chief Designer	£380 by 15—£500 p.a.
Designer	£300 by 15—£350 p.a.
Chief Testing Engineer	£350 by 15—£500 p.a.
First Assist. Testing Engr.	£250 by 10—£350 p.a.

In addition to the above scales, bonus, which is able to variation every 6 months, is payable.
The present bonus on £380 is £142, on £350 is £135, on £300 is £123, and on £250 is £111.

5. Preference will be given to ex-Service men.

6. Application forms, which must be completed by all applicants, can be obtained from the SECRETARY OF THE ADMIRALTY (C.E. Branch), Whitehall, London, S.W. 1, together with the regulations governing the selection, and when filled in should be returned to the same address, so as to arrive not later than the 13th December, 1926. An addressed envelope should accompany the request for application forms.

7. Qualified candidates serving under the Admiralty or in other Government Department should forward their applications through the usual Service channels. 4041

The Engineer

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PUBLIC NOTICES

Indian State Railways. The High Commissioner for India is prepared to receive APPLICATIONS for the following APPOINTMENTS :—

(A) THREE ASSISTANT WORKS MANAGERS Senior Scale). Qualifications, ability to reorganise a large works system and lay-out with a view to improve output and reduce costs; ability to initiate and control planning, rate fixing, progress inspection and costing departments; good knowledge of modern gauging methods; experience in production methods throughout a large modern engineering works; sound knowledge of works stores procedure; responsible administrative experience in large engineering works, but locomotive and carriage and wagon experience not essential; age 30 to 40 years.
(B) THREE ASSISTANT WORKS MANAGERS, and (C) FOUR PRODUCTION ENGINEERS (Junior Scale). Qualifications, sound knowledge of modern production methods with special training in machine shop practice; good designer of jigs and tool and fixtures and able to make tool lay-outs; sound knowledge of planning and rate fixing and capable of laying out detailed manufacturing operations; competent to supervise demonstrations of operations on all classes of machine tools; good knowledge of inspection methods and gauging system; should have held responsible position in a large engineering works; locomotive or carriage and wagon experience not essential; age 25 to 35 years.

The appointments will be made on agreement for three years in the first instance, and initial pay within the prescribed scales will be determined with reference to age and qualifications.

Forms of application and further particulars should be obtained from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 18th December, 1925. 4041

Metropolitan Borough of HAMMERSMITH.
ELECTRICITY DEPARTMENT.

The undermentioned superseded PLANT, installed at Hammersmith Electricity Works, is offered FOR SALE, viz.:—THREE BABCOCK and WILCOX BOILERS with SUPERHEATERS.

Specification and full particulars from the Engineer and Manager, Electricity Department, 85, Fulham Palace-road, London, W. 6.

The dismantling and removal of the plant to be carried out by the purchaser at his own expense and risk.

Offers must be submitted to the Town Clerk, Town Hall, Hammersmith, W. 6, endorsed "Tender for Old Boilers," not later than 4 p.m. on Friday, 17th December, 1926.

HUGH ROYLE, Town Clerk.

Town Hall, Hammersmith, W. 6.
22nd November, 1926. 4055

PUBLIC NOTICES

The High Commissioner FOR INDIA is prepared to receive APPLICATIONS for SIX APPOINTMENTS as CIVIL ENGINEERS, Burma Public Works Department. The appointments will be made temporarily on agreement for five years in the first instance, with the prospect, subject to satisfactory service, of permanent employment thereafter.

Candidates must be between 22 and 24 years of age and unmarried. They must have either (1) obtained a recognised University Degree; or (2) passed Sections A and B of the A.M.I.C.E. examination; or (3) passed the Associateship in Civil Engineering of the City and Guilds Institute (Imperial College of Science and Technology); or obtained such other Diploma or distinction in Engineering as may be considered acceptable. In addition, at least one full year's practical experience of Civil Engineering under a qualified civil engineer is required.

The commencing pay will be Rs. 375 a month, plus overseas pay Rs. 150 a month, rising by annual increments to Rs. 525 a month plus overseas pay £15 a month for the fifth year. Overseas pay is admissible only to officers of non-Asiatic domicile.

Further particulars and forms of application should be obtained from the SECRETARY to the High Commissioner for India, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications, 10th December, 1926. 4033

County of London. The London County Council invites TENDERS for the INSTALLATION of THREE 30ft. by 7ft. 6in. LANCASHIRE STEAM BOILERS with FITTINGS and BRICK SETTINGS, &c., at Banstead Mental Hospital, Sutton, Surrey.

Form of Tender and contract, specification and drawing may be obtained on application to the Mental Hospitals Engineer, The County Hall (Room 660), Westminster Bridge, S.E. 1, upon payment to the Cashier of the Council of a deposit of £1 (which will be returnable if a bona fide Tender is submitted and is not subsequently withdrawn), but full particulars may be obtained before the deposit is paid.

The Contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in the "London County Council Gazette."

All persons or firms with whom the Council enters into contract must, save in exceptional circumstances, be on the "King's National Roll."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Tuesday, 14th December, 1926, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX, Clerk of the London County Council.
4072

PUBLIC NOTICES

Crystal Palace School of Prac- TICAL ENGINEERING.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.
PRESIDENT: J. W. WILSON, M.I.C.E., M.I.M.E.
PRINCIPAL: MAURICE WILSON, M.I.C.E.
Assisted by Staff of Lecturers and Instructors.
Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years.
Students admitted at beginning of any term. 3685

City of Chichester. CITY ENGINEER'S DEPARTMENT.
TENDERS are INVITED for the SUPPLY (in truck loads) of 3in. and 4in. CAST IRON SPIGOTED and SOCKETED PIPES coated with Dr. Angus Smith's Solution.
Details from, and prices (per truck-load) to,
F. J. LOBLEY, A.M.I.C.E.,
City Engineer.
Council Offices,
North-street, Chichester.
24th November, 1926. 4084

Bombay, Baroda and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to 11 a.m. on Thursday, 6th January, TENDERS for the SUPPLY of :—
(1) STRUCTURAL STEEL WORK, &c., for ERECTING UNIT and YARD GANTRY; and at Noon on Wednesday, 8th December, TENDERS for the SUPPLY of :—
(2) PAINTS, &c.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for No. 1 and 10s. each for No. 2 (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG, Secretary.
Offices: The White Mansion,
91, Petty France, London, S.W. 1.
22nd November, 1926. 4073

City of Leicester. STORM WATER AND SEWAGE DISPOSAL WORKS.
SALE OF STEAM PUMPING PLANT AT THE BEAUMONT LEYS SEWAGE FARM.
The Corporation have a quantity of STEAM PUMPING PLANT for which they are prepared to receive TENDERS for the WHOLE or any PART.
The plant includes :—No. 3, 20in. Centrifugal Pumps, No. 3, 5in. Centrifugal Pumps; No. 1, 8in. Centrifugal Pump and Fittings, &c.
Three Lancashire Boilers, with Economiser.
The plant can be inspected at Beaumont Leys Effluent Pumping Station by arrangement with the City Surveyor's Department, and offers should be delivered at the Town Hall, addressed to the Chairman of the Sewage Works and Farms Committee, endorsed "Tender for Steam Pumping Plant," NOT LATER THAN WEDNESDAY, DECEMBER 8th, 1926.
H. A. FRITCHARD, Town Clerk.
Town Hall, Leicester. 4032

Mid Sussex Joint Water Board. REINFORCED CONCRETE COVERED SERVICE RESERVOIR.
The above Board invite TENDERS for the CONSTRUCTION of a REINFORCED CONCRETE COVERED SERVICE RESERVOIR (Hennebique System) of about 517,000 gallons capacity at their Balcombe Waterworks, Balcombe, Sussex.
Drawings may be inspected and specification, conditions of contract, bills of quantities and form of Tender obtained at the office of the Engineer, Boltro-road, Haywards Heath, between the hours of 10 a.m. and 4 p.m., on payment of a deposit of £3 3s., which will be returned on receipt of a bona fide Tender with bills of quantities and schedule of prices fully priced in.
Tenders will be considered only from contractors who have specialised in this class of work.
The Board do not bind themselves to accept the lowest or any Tender, and persons tendering must do so at their own cost.
Sealed Tenders, endorsed "Tender for Concrete Reservoir," are to be addressed to the Clerk to the Mid Sussex Joint Water Board at his office in Boltro-road, Haywards Heath, and delivered not later than 10 a.m. on Thursday, the 16th day of December, 1926.
F. MARTIN, C.E., M.I. Mech. E.,
Engineer.
Waterworks Offices,
Haywards Heath,
20th November, 1926. 4050

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PUBLIC NOTICES

Fylde Water Board.

AQUEDUCT NO. 5 CONTRACT.
DISPOSAL OF PLANT.

The Fylde Water Board are prepared to receive OFFERS for all or any of the CONTRACTORS' PLANT and MATERIAL lying at their Depot at Longridge, near Preston.

All plant, the main items of which are set out below, is in good condition and running order and open to inspection.

A full list of the plant and material for disposal and permission to view can be obtained from the undersigned.

Offers, marked "Aqueduct No. 5 Plant," should be received by me not later than first post Tuesday, December 7th, 1926.

GEO. F. ATKINSON,
Engineer.

Head Office,
Sefton-street, Blackpool.

2 Austin PETROL-DRIVEN TRENCHING MACHINES, each capable of digging a trench up to 4ft. wide by 8ft. deep.
2 Austin CRANE TYPE TRENCH FILLERS, driven by 99 H.P. Petrol Engine mounted on caterpillars.
3 AIR COMPRESSORS, maker Broom and Wade, Dorman Engines, capacity 200 cu. ft. free air per minute.
2 Johnson TAMPING MACHINES, driven by 3 H.P. Petter Engine.
1 Hamworthy PETROL-DRIVEN WINCH.
3 PETROL-DRIVEN CENTRIFUGAL PUMPS, mounted on road wheels, 4in. suction, 3in. delivery, capacity 230 gallons per minute.
One 2-Ton HAND DERRICK CRANE.
One 40 H.P. "Simplex" PETROL LOCOMOTIVE, 2ft. gauge.
2850 Yards PORTABLE RAILWAY TRACK, 2ft. gauge.
6 SETS POINTS and CROSSINGS.
15,000 Yards F.B. RAILS, chiefly 22/24 lb.
7000 WOOD SLEEPERS, 4ft. long.
PNEUMATIC TOOLS, DIAPHRAGM PUMPS, JACKS, BARROWS, SHOVELS, HUTS, CABINS, TOOL BOXES, CHAIN BLOCKS, SHEAR LEGS, GANTRIES, TIMBER, ROPE BLOCKS, BARS, &c.
3957

Hillingdon Cemetery Joint COMMITTEE.

The Committee invite TENDERS for the DRAINAGE and LAYING OUT of ADDITIONAL CEMETERY of some 6 acres adjoining their present Cemetery, Hillingdon, Middlesex.

Bill of quantities and form of Tender may be obtained and plans and specification inspected at the offices of the Committee's Surveyor, Mr. William L. Eves, F.R.I.B.A., F.S.I., 54, High-street, Uxbridge, Middlesex, upon payment of Two Guineas, to be refunded upon receipt of a bona fide Tender.

The Committee cannot bind itself to accept any Tender.

Sealed Tenders, endorsed "Tender, Hillingdon Cemetery," to be delivered to the undersigned not later than Wednesday, the 15th day of December, 1926.

W. O. LOVIBOND,
Clerk and Registrar.

Offices: 1, Vine-street,
Uxbridge, Middlesex.
22nd November, 1926. 4048

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of:—

1. TIN INGOTS.
2. MILD STEEL BARS, SECTIONS, &c.
3. BOLTS, NUTS, RIVETS, &c.
4. BEST YORKSHIRE IRON.
5. STEEL RAILS and FISH-PLATES.
6. FISH BOLTS, NUTS and SPIKES.
7. SPRING STEEL.
8. GALVANISED CORRUGATED SHEETS, &c.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Tin Ingots," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 10th December, 1926.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of Specifications Nos. 1 to 6, and 5s. for each copy of Specifications Nos. 7 and 8.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1.
23rd November, 1926. 4079

County Borough of Brighton. WATERWORKS DEPARTMENT.

APPOINTMENT OF ASSISTANT ENGINEER.

The Council invite APPLICATIONS for the APPOINTMENT of ASSISTANT ENGINEER at a commencing salary of £450, rising to £500 per annum at the end of 12 months.

The appointment will be for a period of six months in the first instance, and will be made permanent, subject to satisfactory service during that time.

Applicants, who should have passed the Associate Membership Examination of the Institution of Civil Engineers, must have considerable experience in the design of modern steam pumping plant, buildings, service reservoirs, &c., as well as the general administrative work of a large waterworks undertaking.

Applications, in the candidates' handwriting, stating age, training, experience and qualifications, together with copies of three recent testimonials, should be forwarded to the undersigned on or before the 20th December, 1926, endorsed "Assistant Engineer, Waterworks Department."

Canvassing, either directly or indirectly, will be a disqualification.

Town Hall, Brighton. JAS. H. ROTHWELL,
18th November, 1926. Town Clerk.
4052

Ely Urban District Council.

The Ely Urban District Council invite APPLICATIONS for the APPOINTMENT of SANITARY INSPECTOR and ASSISTANT SURVEYOR.

The person appointed must hold the necessary qualifications to perform the duties prescribed by the Sanitary Officers Order, 1926, and the duties of Assistant Surveyor, and will be required to devote his whole time to the duties of the combined offices.

Applications, on forms which may be obtained from me, the undersigned, together with copies of three recent testimonials, must be sent so as to reach me not later than Wednesday, the 8th December, 1926.

The salary of the combined offices is £200 per annum.

A. K. CAMPBELL,
Solicitor and Clerk to the Council.

Market-square, Ely, Cambs.,
23rd November, 1926. 4086

Great Southern Railways.

A STEEL WORK DRAUGHTSMAN and FOUR JUNIOR CIVIL ENGINEERING DRAUGHTSMEN are REQUIRED by the GREAT SOUTHERN RAILWAYS, IRELAND.

Applicants for the former vacancy should have had considerable experience in the design of Bridges and Roofs, either in a Railway Engineer's Office or in a Bridge Builder's Office. Commencing salary £300 per annum.

Four Junior Civil Engineering Draughtsmen are required who should not be more than 25 years of age and who need not have had previous experience, if they have had a training in a School of Civil Engineering. Commencing salary £150 per annum.

Applicants for any of these vacancies should state age and give particulars of training and experience, and send not more than two copies of recent testimonials.

Applications should be posted so as to reach the undersigned not later than 10 a.m. on 4th proximo.

C. E. RILEY, Secretary.

Kingsbridge Station, Dublin,
15th November, 1926. 3990

PUBLIC NOTICES

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited.

25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for:—

200 TONS (Approx.) SPRING STEEL.

Tenders are due in on Tuesday, 14th December, 1926, by 2 p.m. Tender form obtainable at above address, fee One Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 4074

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED by Allied Engineering Trade, TECHNICAL and SALES ASSISTANT with shop and drawing-office experience.—Address, stating age and qualifications, P2513, The Engineer Office. P2513 A

WANTED, CHEMICAL ENGINEERING DESIGNER by Engineering Works in the North-West of England. Must be thoroughly conversant with Chemical Engineering generally and especially Sulphuric Acid, Alkali, and Artificial Silk Plant. Age not over 45.
Send full personal particulars and experience, stating salary required.
Address, 4029, The Engineer Office. 4029 A

WANTED for India, ENGINEER SALESMAN, conversant with Air Compressing and Pneumatic Plant for Mining and Workshop use. Age not over 28, must be single. State fullest details of education, experience, and salary required.—Write, "Z.K. 178," c/o Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 4047 A

A LARGE CONTINENTAL CONCERN Invite APPLICATIONS for MANAGER of their London house. Preference given to those who are thoroughly conversant with the Machine Tool line and have some knowledge of German.—Please address, stating age, experience, and remuneration required, 4049, The Engineer Office. 4049 A

ASSISTANT ENGINEERS REQUIRED for Large British-owned Railway in Argentina. Applicants should be between 25/35 years of age, connected with Institution of Civil Engineers, and possess practical experience in Railway Construction.—Apply by letter, stating age, training, experience, if able to speak Spanish, salary required, and with copies (only) of testimonials, to Box N.B.A., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 4046 A

ASSISTANT WORKS MANAGER for Constructional Steel Work. Modern workshop experience essential.—Write, giving experience, references, salary required, &c., CHARLES WADE and CO., Ltd., Aston-road, Birmingham. P2530 A

CIVIL ENGINEER REQUIRED for Kenya Colony with considerable experience of Harbour and Dock Construction. Salary £800 to £900 per annum, according to qualifications and experience. Free quarters and liberal leave on full salary.—Apply by letter, stating age, qualifications and experience, to K. H. W., c/o Brown's, 39, Tothill-street, S.W. 1. 4082 A

ENGINEERING FIRM, Specialising in Manufacture of Power-house Plants, Water-tube Boilers and Accessories, DESIRE to ENGAGE SERVICES of PUBLICITY EXPERT, take entire control of the publicity and advertising side of their business.—Address in first instance, giving full particulars as to qualifications, salary expected, and whether whole or part-time services suggested, 4068, The Engineer Office. 4068 A

INTELLIGENT YOUNG MAN with Ideas on publicity WANTED for Catalogues, Spare Parts Lists, &c. Must be capable of taking charge of drawing-office in absence of chief.—Address, 4002, The Engineer Office. 4002 A

PUBLICITY.—Large FIRM of ENGINEERS and MACHINE TOOL MAKERS REQUIRE YOUNG MAN of good education, with engineering knowledge and experience of publicity work, capable of preparing catalogue matter and taking charge of advertising. Applicants must give full particulars of experience, state age and salary required.—Address, 4039, The Engineer Office. 4039 A

REQUIRED by Midland FIRM, Experienced CASE HARDENER, with commercial knowledge, to Take Charge of Sales Dept. Only men with practical experience and able to demonstrate need apply. State age, particulars, and terms required.—Address, 4062, The Engineer Office. 4062 A

SALES DIRECTOR, with Experience of Colonial and South American markets, preferably with knowledge of Sawmill Industry. State age, salary and qualifications.—SPEAR and JACKSON, Ltd., Aetna Works, Sheffield. 4088 A

THE STANTON IRONWORKS COMPANY, Ltd., near Nottingham, REQUIRE the SERVICES of a FOUNDRY WORKS MANAGER.—Apply in writing, giving age and full particulars of experience, to the FOUNDRY GENERAL MANAGER, Stanton Ironworks Company, Ltd., near Nottingham. 4025 A

WELL-KNOWN FIRM of Machine Tool Makers REQUIRE IMMED. ENGINEER (single pref.), well versed in modern Automobile Production methods. Must have good shop exp., also D.O., especially Jig and Tool Design, and ability to prepare tool lay-outs. Applications will be treated strictly confidential.—Address fullest particulars of experience, age, salary, &c., P2517, The Engineer Office. P2517 A

WANTED, DRAUGHTSMAN, Experienced in Pumping Machinery, with special knowledge of Turbine and Centrifugal Pumps. State salary required and experience, with names of previous employers (which will be treated in strict confidence).—Address, 3986, The Engineer Office. 3986 A

WANTED IMMEDIATELY, First-class MECHANICAL DRAUGHTSMAN, preferably (but not essential) with experience of Mining Machinery, including latest types of Coal Cutters, Conveyors, and Haulage Gears. Permanency for thoroughly good man with initiative.—Address, 4051, The Engineer Office. 4051 A

DRAUGHTSMAN, Temporary, to Work Out Details and estimates to our specification and supervise the work for an Inclined Concrete with Girders Road, preferably one who has also machinery, workshop and running experience, some commercial nous and a worker, in which case there may be further work with a possible permanent future betterment. Mr. Wedgwood might suit.—Address, 4061, The Engineer Office. 4061 A

ELECTRIC LOCOS.—METROPOLITAN-VICKERS ELECTRICAL CO., Ltd., Trafford Park, Manchester, REQUIRES a DRAUGHTSMAN for Mechanical Structure Work. Electrical experience not necessary.—Applications to be made in writing, addressed to the COMPANY'S EMPLOYMENT DEPARTMENT (marked "Electric Locos."), stating age, experience, and salary required. 4089 A

JUNIOR DRAUGHTSMAN, Mechanical. Write, stating experience and age. Wages to commence 50s. Good opportunity for advancement.—Address, P2504, The Engineer Office. P2504 A

JUNIOR DRAUGHTSMAN REQUIRED for Westminster. Shops experience. Must be neat and accurate and first-class tracer. Also a First-class TRACER REQUIRED.—Address, 4087, The Engineer Office. 4087 A

STRUCTURAL STEEL WORK DETAILING DRAUGHTSMAN for London, fully qualified man. State age, experience, and salary required.—Address, P2502, The Engineer Office. P2502 A

SITUATIONS OPEN (continued)

MARINE ENGINEER FOREMAN WANTED by Shipbuilders and Repairers in China. Must be experienced in all types of Diesel Marine Engines, also having practical steam experience, with Chief Engineer's Certificate. Aged about 35.—Address, fully detailing experience, P2480, The Engineer Office. P2480 A

WANTED for Firm near London, TWO PIPE FITTERS. Must be efficient with their work. Used to carrying out jobs on their own. Experienced with Steam, Water and Gas Installations. Only skilled men need apply. Full particulars of experience, stating if able to do any sheet metal work or acetylene welding.—Address, 4060, The Engineer Office. 4060 A

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A Seven-Day Journal

A Vast Reorganisation Programme.

As part of its policy of national economic reorganisation, the French Government has prepared a programme which will involve an immediate considerable expenditure upon public works. A Committee composed of the Ministers interested has drawn up a plan which will be submitted to the Cabinet and will then be incorporated in a Bill to be presented to Parliament in the coming session. The plan is arranged under three heads, one dealing with an intensive organisation of agricultural production; another providing for the substitution of hydraulic power for coal, the production of "national" liquid fuels to replace imported petrol, and a more active production of minerals; and the third covering a vast organisation of colonial development, which is to provide the home country with wool, cotton, rubber, oils and other raw material. For the colonial scheme it is believed that credits will be asked for amounting to 400 million francs a year. It is urged that this heavy sacrifice is fully justified by the huge profits which the colonial works will provide in a dozen years' time. Meanwhile, it is announced that a German financial group is in negotiation with the French Government for the execution of public works at Verdun and in the Department of the Seine. This arrangement is in pursuance of the programme which the Governments of the two countries are seeking to carry through for a mutual collaboration in accordance with the Thoré Conference. The cost of the works will be about 25 million marks, a part of which will be on account of reparations.

A Serious Railway Accident.

The worst railway accident that has happened in this country since the Lytham derailment of November 3rd, 1924, occurred on Friday, the 19th, just south of Parkgate and Rawmarsh Station, on the Midland section of the London, Midland and Scottish Railway. The line at that point runs approximately north and south, and there are four running roads which, reading from the west, are the down fast, up fast, down slow, up slow. At the moment of the accident the 10.10 a.m. express from York to Bristol was approaching on the up fast line and a goods train was on the down slow. Apparently a draw-bar broke on a wagon of the latter train, causing it and other wagons to be derailed and so to foul the up fast line as the express was passing. As a result the sides of the last three of the five coaches of the passenger train were torn open, and six passengers were killed instantly, whilst three died subsequently from their injuries. Colonel Sir John Pringle opened his inquiry into the cause yesterday—Thursday. One point of interest may, however, now be disposed of. The Government requirements for new railways call for a space of 9ft. between such parallel lines. That distance had evidently been provided, as a signal was concerned in the wreckage, and it would need a space of 9ft. 6in. at least.

The Karachi Airship Base.

If the two huge airships, each of 5,000,000 cubic feet capacity, now under construction in this country, are to be used for anything more than isolated experimental flights between Britain, India and Australia, it would seem fairly obvious that somewhere along the route a station equipped with something more than a mooring mast will be required. Facilities for housing and repairing the airships are required at each end and possibly at some central point. In this country the Cardington sheds erected during the war near Bedford have been enlarged to provide the necessary accommodation. For some time past preparations have been in hand for building a new airship base at Karachi, with a huge shed as its central feature. Particulars concerning this work have, for certain reasons, not been published, but it is now no secret that the shed is being constructed by the Armstrong Construction Company, Ltd., and that a beginning has been made on the site. From a reply given in Parliament on Friday of last week by the Under-Secretary for Air, we learn that the site has been cleared, the foundations for the shed have been laid, and many auxiliary works completed. It is anticipated that the work now in hand will be finished towards the end of 1927. The Karachi base and shed will serve as the principal airship station in India, but if the service is to be extended to Australia at a later date, a similar base and shed would seem to be necessary in that country as well.

Further Shipbuilding Orders.

Although it is hardly to be expected that supplies of industrial coal will be such as to allow the shipyards to resume normal activity much before the beginning of the New Year, yet shipbuilders appear to be optimistic as regards the future. Several ships have recently been ordered. Sir W. R. Smith and Sons, Ltd., of Cardiff, have placed an order for four cargo ships which will bring work both to the Clyde and the North-East Coast. The ships will be of about 9000 tons deadweight carrying capacity, or about 5800 gross. Two are to be constructed by Napier and Miller, Ltd., of Old Kilpatrick, and engined by David Rowan and Co., Ltd., of Glasgow; and two will be built at the Wear Yard, Sunderland, by William Gray and Co., Ltd., of West Hartlepool. A Tyne order which has not previously been referred to in our pages is that for three 10,000-ton oil tankers, which has been placed with Palmer's Shipbuilding and Iron Co., Ltd., of Jarrow-on-Tyne, by British Tankers, Ltd., of London. On the Mersey Cammell Laird and Co., Ltd., of Birkenhead, are to build two motor vessels, each of about 9000 tons deadweight carrying capacity, which are to be used for the New York and Far East service of the Lancashire Shipping Company, Ltd., and have been ordered for that company by its managing owners, James Chambers and Co., of Liverpool.

Wreck Returns.

The wreck returns which were recently published by Lloyd's Register of Shipping show that for the quarter April 1st to June 30th, there was, according to the reports received up to October 30th, a total reduction in the world's mercantile fleet of 99 ships, aggregating 193,433 gross tons. This total reduction from all causes was made up of 79 steamers and motor ships and 20 sailing ships, of which 19 steamers and motor ships were owned in Great Britain and Ireland. Of this number two ships were lost in collision and two others were wrecked, accounting for 7724 tons, which is 0·05 per cent. of the ships owned and 0·04 per cent. of the tonnage owned. The other 15 British-owned ships, representing some 42,525 gross tons, were either broken up or condemned, and were not lost in consequence of casualty or stress of weather. In the returns the losses are tabulated according to cause for each country, and particulars of the ships so lost are grouped under the heading of the various causes of loss.

The Electricity (Supply) Bill.

In moving the second reading of the Electricity (Supply) Bill in the House of Lords on Tuesday last, Viscount Peel said that the object of the Bill was to secure the production of electrical power on the largest possible scale and at the lowest possible price. In due course all high-tension energy generated by authorised undertakers would be produced under control and sold through a Board to authorised undertakers. The Bill did not deal with the distribution, that matter being left to the authorised undertakers, irrespective of whether they were municipalities or companies. The justification of the Bill was that, while electricity was becoming more and more the motive power of industry, Great Britain was falling behind her industrial competitors in that respect. Viscount Haldane said that the idea that the Bill was Socialistic was utterly fallacious and founded on a misunderstanding of the measure. No adequate provision was made for standardising distribution, but in other respects the Bill was a good one. The scheme was valuable from a military point of view, because if London generating stations were bombed the Metropolis could be supplied from the Midlands. It would be a help to the conversion of railways from steam to electricity and it would facilitate the development of electrically propelled road vehicles. Lord Weir, who presided over the Committee which issued the report that formed the basis of the Bill, said that in an industrial country such as ours an adequate and readily available supply of cheap electrical power was an essential of fundamental importance and of ever increasing value. The review made by his Committee disclosed that this country possessed assets which, if properly utilised and co-ordinated, could yield a supply of electrical energy at costs so favourable as to confer on the industries of the country a competitive advantage over other countries in all cases other than those where a particular industry could be located in the closest proximity to readily available water power. Lord Banbury said it would be well if the Government would devote its attention to seeing how little money it could lose on telephones and telegraphs, rather than risk more money on other undertakings.

Airship Tests.

The British airship R33, on Tuesday, November 23rd, carried out what are apparently to be the last tests of the series for which she was recommissioned a year or so ago. The tests were principally concerned with the operation of mooring her to the new mooring mast which has been erected at Cardington and which is the first of a number which it is proposed to erect in the Dominions for facilitating the operation of the two large airships now under construction in this country. The mast has a height of 200ft. to the landing platform and is an open lattice work conical structure. It was built by the Cleveland Bridge and Engineering Company, of Darlington. At its centre it contains a stairway and a hoist, the latter having been supplied by Babcock and Wilcox, Ltd. The airship is moored to the mast by means of a central cable from her nose and side guys, all the tackle being taken over pulleys to an electrically controlled winding engine at the foot of the mast. The side guys steady the vessel while the central cable pulls her nose down to the masthead, where it is eventually locked to a moveable arm. The tests on Tuesday were carried out satisfactorily, and subsequently experiments with parachutes and with the release from the airship of two Gloucester "Grebe" single-seater fighting aeroplanes were made. The airship then left for the Pulham aerodrome, where it is understood she will be laid up indefinitely. Her removal from Cardington will enable the construction of the five million cubic foot Government airship to be expedited.

The Proposed Doncaster Ship Canal.

On Tuesday of this week a conference was held at Doncaster to discuss the proposal that a ship canal should be constructed between the river Trent and Doncaster, with a possible extension to Sheffield. The conference was convened by Colonel Somerville, of Doncaster, who is clerk to the Hatfield Chase Commissioners. It was attended by representatives of the canal, drainage and colliery interests in the South Yorkshire coalfield and of the Federation of British Industries. The cost of providing such an outlet to the sea for the South Yorkshire coalfield was stated to be about £11,000,000. Some discussion took place on the practicability of making a navigable waterway which at the same time would act as a drainage canal for a large area of already low-lying ground, which with continued mining operations may still suffer additional subsidences. The conference decided that further engineering advice was needed before a final scheme could be prepared. The fear was expressed that if it became necessary to raise the banks of the waterway in order to give protection against further possible subsidence, then the cost of the undertaking might prove prohibitive. A sub-committee was appointed by the conference, and it will report in time to prepare a scheme which is to be presented to the Royal Commission on Mining Subsidence, which is to hold its public inquiry in January.

The Coal Dispute.

On Friday, November 20th, it was disclosed that the miners of the country, voting by lodges and not by individual ballot, had rejected the terms put forward by the Government as a basis of settling the coal dispute by a majority of 460,806 to 313,200. On the same day there were 376,374 workers employed in and about the mines of the country producing coal and the number returning to work was steadily increasing at a rate of over 10,000 a day. The rejection of the Government's terms placed the miners' leaders in an almost farcical quandary. After much discussion they decided not to stand on the strict interpretation of the voting result. Instead they resolved to recommend all the districts to open negotiations immediately with the local coalowners with a view to arriving at agreements. No final settlement in any district, it was specified, was to be entered into until a national conference had been held to receive reports of all the negotiations. The general principles which should guide the district organisations were left to the miners' Executive Committee to settle. A statement of these general principles was duly issued on the following day. While they contained several terms which the owners are unlikely to concede, they were distinguished by the fact that no mention was made of the hours to be worked. The local negotiations were opened on Monday, November 22nd, and were to be completed in time for their final review by the delegate conference at its meeting to-day—Friday. Reports generally indicate that on the whole the district negotiations have proceeded smoothly and that little difficulty has been encountered in coming to provisional agreements. The latest available reports indicate that the number of miners now at work has reached a total of over 420,000. Yesterday (Thursday) restrictions on the industrial use of coal, gas and electricity were withdrawn.

America's Merchant Fleet.

In a Journal note of November 12th we gave some particulars of the offers which had been made to the United States Shipping Board for the chartering or sale of the merchant fleets it is now operating. According to later reports from America it seems unlikely that either the Atlantic or South American services will pass from State to private ownership at any very early date. Of the six bids for the ships of the United States Lines and the American Merchant Line three have been rejected on various grounds. The three remaining bids are those of J. H. Winchester and Co., William F. Kenney and Associates, and the group associated with Mr. Kermit Roosevelt. Each of these interests is prepared, it is stated, to buy the ships of the American Merchant Line and to charter the fleet of the United States Lines. It will be recalled that the J. H. Winchester Company also offered to build two new passenger liners at a cost of about £6,000,000, provided that two-thirds of this sum was granted under loan by the Shipping Board. With regard to the South American fleets, which include the American Republic, American Delta and American Despatch Lines, only two offers were received, which were rejected as not conforming to the conditions specified. They were made by the Munson Steamship Line and the Moore and McCormack Company, which latter concern is at present operating the American Republic Line. Both these firms were willing to make offers on other terms than those proposed by the Shipping Board.

Main Line Railway Electrification.

By Sir PHILIP DAWSON, M. Inst. C.E., &c., Consulting Engineer, and
S. PARKER SMITH, D.Sc., M.I.E.E., Professor of Electrical Engineering, Royal Technical College, Glasgow.

No. XIV.—U.S.A.: NORTH-EASTERN STATES.*

A.—NEW YORK CENTRAL RAILROAD.†

1. Historical: Reasons for Electrification.

The passenger trains of the N.Y.C.R.R., and also of the New York, New Haven and Hartford R.R., enter Manhattan Island, New York City, over the Harlem River, thence by a 3 kilom. tunnel below Park-avenue reach the Grand Central Terminus at Forty-second Street. As long ago as 1899 conversion to electric haulage had been considered in consequence of the atmospheric conditions brought about by the presence of smoke and steam in the tunnel, which culminated in a serious tunnel accident in 1903, involving the loss of many lives. The New York State Legislature then ordered the abolition of steam haulage within the City boundaries by July 1st, 1908. As it was impossible to arrange for the change of locomotives on the north shore of the Harlem River, it was decided to extend the electrified zone about 30 miles from the terminus, and to operate all suburban traffic by electric power. Simultaneously with this decision the company arranged for the reconstruction of the Grand Central Terminus to increase its convenience and capacity. The conversion and reconstruction were completed in 1906, and no further extensions have since been made.

2. Choice of System.

The electrification system is direct-current at 650 volts with a third-rail under-contact conductor. At the time of the decision for electrification, the only available practical system was the low-voltage direct-current arrangement with third-rail conductor. The use of the under-contact conductor-rail was intended to obviate interference from snow and sleet. (The later decision of the N.Y.N.H.H.R.R. to use alternating current at 11,000 volts with overhead contact line on its own lines precipitated the so-called "battle of the systems.") Great care was taken to ensure the reliability of the system by the duplication of the power supply and the installation of secondary batteries at the synchronous converter sub-stations.

3. Extent of the Present Electrification.

The maps—Figs. 1 and 2—show the extent of the N.Y.C. electrification from the Grand Central terminus to Croton, on the Hudson division; and from Motthaven to North White Plains, on the Harlem division. The route lengths are:—

	Kiloms.
Main tunnel section, G.C. terminus to Motthaven Junction	8·5
Motthaven to Croton	46·0
Motthaven to Bronxville	16·1
Bronxville to N. White Plains	14·0
	84·6

The last-named section has two tracks, the others have four tracks, giving an aggregate length of electrified track, including yards and termini, of 516 kiloms.

4. General Description.

(*a*) *Power Supply.*—As a measure of security, energy is furnished from two power stations working in parallel, and owned by the railway company. One station is situated at Port Morris, on Long Island Sound, the other at Glenwood, near Yonkers, on the bank of the Hudson River. At the outset each station was equipped with four vertical-shaft 5000-kilowatt three-phase 11,000-volt 25-cycle steam turbo-generators. Three 20,000-kilowatt horizontal-shaft sets have since been installed at Port Morris, whilst two 5000-kilowatt sets have been removed. Three-phase energy at 11,000 volts is distributed to the sub-stations by a pair of independent circuits in cables aggregating 26 kiloms., and—for less populated districts—68 kiloms. of 105 mm.² overhead transmission line on steel towers.

(*b*) *Sub-stations.*—There are twelve sub-stations, spaced as shown in Fig. 1, containing step-down transformers and synchronous converters, and, in some cases, secondary batteries. The sub-stations supply the track at 600 volts. Sections Nos. 1, 1A, and 2 feed the main line between the terminus and Motthaven; Nos. 3–6 are on the main Hudson division; and Nos. 7–9 on the N. White Plains branch. The three latest sub-stations, Nos. 1A, 7A and 8A, are automatic with remote control. Table I. summarises the equipment of the sub-stations.

(*c*) *Conductor Rail.*—Current is collected by the trains from "under-running" third-rail conductors, situated at the side of the track. The arrangement has the advantages of avoiding contact difficulties brought about by sleet and deep snow, and of being easily protected from accidental contact by railway *personnel*. The contact rail is of special steel and weighs 35 kilos. per metre. The suspension arrangement is shown in Fig. 3. The chairs are spaced 3 m. apart, and carry the rail by means of split porcelain insulators. The rail has some play in the insulators; it is protected at the top and sides by deal planks.

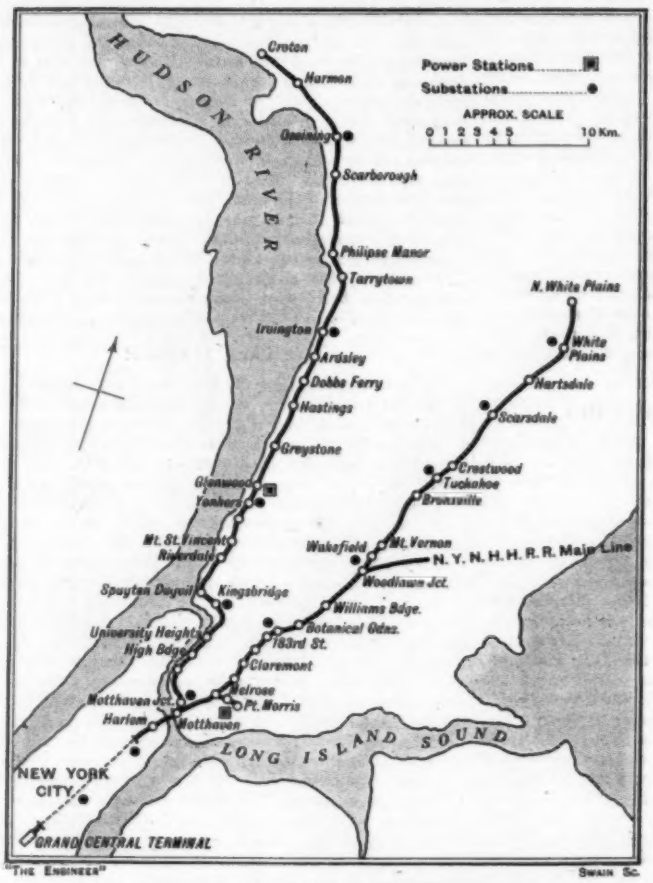


FIG. 1—NEW YORK CENTRAL R.R.—ELECTRIFIED SECTION

FIG. 2—NEW YORK ELECTRIFIED RAILWAYS

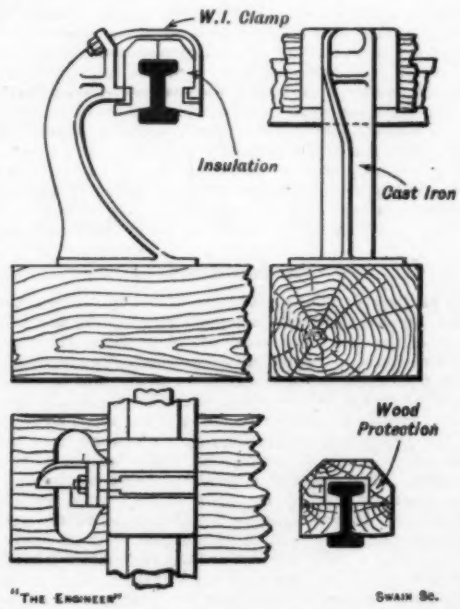


FIG. 3—THIRD RAIL, N.Y.C.R.R.

Table I.—*Sub-stations, New York Central R.R.*

Sub-station. No.	Situation.	Converter sets.	Total capacity.
		kW.	kW.
1	50th Street	1 × 2500 1 × 2000 4 × 1750	11,500
1A	110th Street	2 × 2000	4,000
2	Mott Haven	3 × 1750 1 × 2000	7,250
3	Kingsbridge	3 × 1250 1 × 2500	6,250
4	Glenwood	3 × 1250 1 × 2000	5,750
5	Irvington	1 × 2500 2 × 2000	6,500
6	Ossining	1 × 2500 3 × 1250	6,250
7	Bronx Park	3 × 1250 1 × 2000	5,750
7A	Wakefield	1 × 2000	2,000
8	Tuckahoe	3 × 1250	3,750
8A	Scarsdale	1 × 2500	2,500
9	White Plains	3 × 1250	3,750

Consecutive conductor rails are bonded with laminated copper of 250 mm.²; the running rails are bonded with two 225 mm.² copper bonds. The feeders leaving the sub-stations are of various cross-sections, according to the traffic requirements, and comprise 375, 500 and 650 mm.² sizes.

(*d*) *Locomotives.*—The locomotive stock comprises 73 gearless engines of the General Electric Company's construction. In 1904 an experimental locomotive was tested on a special 6-mile track at Schenectady.

* Nos. I., II. and III. (Switzerland) appeared June 6th, 13th and 20th, 1924; Nos. IV. and IV.A (Scandinavia) appeared January 23rd and February 6th, 1925; Nos. V. and VI. (Germany) appeared June 5th and 12th, 1925; Nos. VII. and VIII. (Austria) appeared August 21st and 28th, 1925; Nos. IX. and X. (France) appeared October 2nd and 23rd, 1925; Nos. XI. and XII. (U.S.A., North-Western States) appeared February 12th and 26th, 1926; and No. XIII. (U.S.A., South-Eastern States) appeared March 26th, 1926.

† General particulars of this and the other lines dealt with in this series of articles are given in Table II.

TABLE II.—U.S.A. (NORTH-EASTERN STATES) MAIN LINE RAILWAY ELECTRIFICATION

Railway.	No.	Section.	GENERAL. Date opened for electric traction.	Route length.	No. of tracks.	Gauge.	CONTACT LINE. Current, voltage, frequency.	Contact line.	Return.	Contact line suspension.	Description and spacing of supports.	POWER SUPPLY. No. of feeding points.	Feeding points.	Mean distance between feeding points.	Feeding lines.	Transmission lines.	Power stations.
				km.		m											
NEW YORK CENTRAL R.R.	1	Grand Central terminus, New York City, to Croton, Bronxville and N. White Plains	1906	84·6	4 (2 on N. White Plains branch)	1·435	D.C. 600 volts	Third rail, underrunning type, 35 kg. per m.	Running rails	Cast iron brackets	3 m.	12	*Converter sub-stations :—* Sets. kW. 50th Street .. 1 × 2500 1 × 2000 4 × 1750 110th Street .. 2 × 2000 Mott Haven .. 3 × 1750 1 × 2000 Kingsbridge .. 3 × 1250 1 × 2500 Glenwood .. .. 3 × 1250 1 × 2000 Irvington .. .. 1 × 2500 2 × 2000 Ossining .. .. 3 × 1250 1 × 2500 Bronx Park .. 3 × 1250 1 × 2000 Wakefield .. 1 × 2000 Tuckahoe .. .. 3 × 1250 Scarsdale .. .. 1 × 2500 White Plains .. 3 × 1250	7·05		26 km. of 11,000-volt, 3-ph. cable, two independent circuits 67 km. of 105 mm², 3-ph. overhead transmission line on steel towers	*Yonkers* (steam) : 4 × 5000 kW, 11,000-v., 3-ph 25-cycle turbo-generators *Port Morris* (steam) : 1 × 5000 kW. and 3 × 20,000 kW, 11,000-v., 3-ph., 25-cycle turbo-generators
NEW YORK, NEW HAVEN, AND HARTFORD R.R.	2	Grand Central terminus, New York City, and Harlem River, to New Haven and branches	1907–17	195	6, 4, 2, or 1	1·435	Single-phase, 11,000 volts, 25 cycles	Various types. simple, compound and double catenary	Rails and feeders of three-wire system	6·7 m. above track	Lattice girders or cross wires, 90 m. spacing	2 (22)	Three-wire system with 22 auto-transformers and 24 balancing transformers. Main feeding from Cos Cob power station and West Farms sub-station	97·5 (8·9)	Three-wire system. Feeders on same supports as contact line	See feeding lines	*Cos Cob* (steam) : 3 × 12,850 kVA, 1 × 4160 kVA, and 4 × 5000 kVA, 11,000-v., 25-cycle turbo-generators. Also purchased power
PENNSYLVANIA R.R.	3	N.Y. terminus, Manhattan Transfer to Sunnyside Yard	1910	23	2and 4	1·435	D.C. 650 volts	Third rail, overrunning type, 75 kg. per m.	Rails	C.I. brackets		4	*Converter sub-stations :—* Sets. kW. Harrison .. .. 3 × 2000 1 × 4000 Hackensack .. 3 × 2000 Penna. Sta. .. 3 × 2000 1 × 4000 Sunnyside Yard 3 × 2000 1 × 4000	5·7		11,000-volt, 3-ph., 25-cycle lines in cables or overhead	*Long Island City* (steam) : 2 × 15,000-kW, 2 × 5500 kW, 2 × 6000 kW, 2 × 3000 kW, 11,000 v., 25-cycle turbo-generators
	4	Philadelphia terminus to Paoli and Chestnut Hill and branch	1915 1918	58	2 and 4	1·435	Single-phase 11,000 volts, 25 cycles	Steel catenary cable. Copper auxiliary wire. Bronze contact wire, 70 mm².	Rails	Compound catenary, 6·7 m. above track	Lattice girders or cross wires, 90 m. spacing	5	*Transformer sub-stations :—* Sets. kVA W. Philadelphia 2 × 3000 2 × 2000 Bryn Mawr .. 2 × 2000 Paoli .. .. .. 2 × 2000 N. Philadelphia 2 × 3000 Allen-lane .. .. 2 × 3000	11·6		103 km. of 44,000-volt single-phase, 25-cycle lines on poles	Purchased
BALTIMORE AND OHIO R.R.	5	Baltimore terminus ..	1895	6	2	1·435	D.C., 650 volts	Third rail, underrunning type, 38–50 kg. per m.	Rails			1	*Converter sub-station :—* 5 × 1000 kW for power purchased	6			*Baltimore* (steam) : 5 × 500 kW, 500 volts, D.C.
GRAND TRUNK RAILWAY	6	St. Clair tunnel	1908	6·5	1	1·435	Single-phase, 3300 volts, 25 cycles	Copper contact wire, 108 mm².	Rails	Catenary 6·7 m. above track		1	Direct feeding	6·5			*Port Huron* (steam) : 2 × 1250 kW, 3300-v., 3-ph., 25-cycle turbo-generators
MICHIGAN CENTRAL R.R.	7	Detroit River tunnel ..	1910	7·4		1·435	D.C. 650 volts	Third rail, underrunning type, 35 kg. per m.	Rails			1	*Motor-generator sub-station :—* 4 × 1000 kW	7·4			Purchased
BOSTON AND MAINE R.R.	8	Hoosac tunnel	1911	13	2	1·435	Single-phase, 11,000 volts, 25 cycles	Copper contact wire, 108 mm².	Rails	Catenary 6·7 m. above track		1	Direct feeding	13		8 km. of single-phase, 25-cycle, 11,000-v. line	Purchased
DETROIT, TOLEDO AND IRONTON R.R.	9		1926	21	2	1·435	Single-phase, 23,000 volts, 25 cycles		Rails	Catenary							*River Rouge* (steam)

TABLE III.—U.S.A. (NORTH-EASTERN STATES) ELECTRIC LOCOMOTIVES

Railway.	Series No.	No.	Axles. Driv'g.	Axles. Pony.	Type.	Weight. Total.	Weight. Adhes.	Weight. Elec. equip.	Weight. Per axle.	Length over draw-gear.	Wheel base.	Wheel dia. Driv'g.	Wheel dia. Pony.	Motors	Motor voltage	No. of motors.	Loco. horse-power (1-hour).	Tractive effort. (1-hour).	Speed (1-hour).	Speed (max.).	Weight per H.P.	Drive.	Gear ratio.	Speed regulation.	Current collectors.	No. of transformers	Cooling of transformers	Braking.
						t.	t.	t.	t.	m.	m.	m.	m.		v.		h.p.	kg.	km./hr.	km./hr.	kg.							
New York Central R.R.	1100–34	35	4	4	2 AAAA 2	103	63	27	15·7	11·80	9·95	1·12	0·84	D.C. series	600	4	2,200	9,700	62	129	47	Direct gearless	—	Series parallel control and field weakening	Shoes	0	—	Air
	1135–46	12	4	4	2 AAAA 2	110	67	27	16·7	13·12	11·00	1·12	0·93		600	4	2,200	9,700	62	129	50							
	1147–56	10	8	0	A A — AA + AA — AA	107	107	34	13·3	16·83	13·90	0·92	—		600	8	2,320	7,800	81	137	46							
	1157–62	6	8	0	AA — AA + AA — AA	119	119	40	15	17·35	14·16	0·92	—		600	8	2,600	9,050	79	137	46							
	1163–72	10	8	0	AA — AA + AA — AA	121	121	41	15	17·35	14·16	0·92	—		600	8	2,600	9,050	72	129	46·5							
New York, New Haven and Hartford R.R.	01–041	41	4	2	1 AA — AA 1	99	76	51	19	11·42	9·38	1·58	—	Single-phase neutralised series.	284*	4	1,260	3,620	95	142	78	Gearless quill	—	Transformer tappings	Pantographs with third rail shoes where necessary	2	Air	Air
	069	1	4	2	1 AAAA 1	105	80	54	20	14·28	11·90	1·60	1·07		330*	4 twin	1,616	7,050	62·5	87	65	Geared quill	4·2			1		
	070	1	4	2	1 B + B 1	122	87	60	21·7	16·40	13·28	1·45	0·92		310*	2	1,300	7,600	46·5	98	94	Jack shaft side rod	—			1		
	071–2	1 frt. 1 pass.	4	2	1 AA — AA 1	127 112	84 83	59 58	21	12·00	10·38	1·60	1·07		380* 342	4	1,428 1,248	4,700	83 72·5	107	89 90	Geared quill	2·1			1		
	073–5	3	4	2	1 AA — AA 1	107	83	53	21	15·25	12·35	1·60	0·92		330*	4 twin	1,616	7,050	62·5	100	66		4·2			1		
	076–0111	‡36	4	2	1 AA — AA 1	100	75	44	19	15·25	12·35	1·60	0·92		330	4 twin	1,616	9,600	46	73	62		4·2			1		
	0300–16	17	6	4	1 AAA — AAA 1	158 161	105 109	79 83	17·7 18·2	21·05 20·34	18·15	1·60	0·92		335* 349	6 twin	2,460	8,150 8,750	82 77	113	64 65·5		3·2 3·5			1		
	0200–15	16	4	0	AA — AA	72 70	72	35 34	18	11·28 11·42	7·18	1·60	—		190 228	4	652	10,500	13 17	40	110 107		5·9			1		
	068	1	4	4	2 AA + AA 2	131	88	55	22	18·90	16·50	1·37	0·84			4	1,800	12,200	37	73	73	Geared side rod	—			1		
	0112–6	5	4	2	1 AA — AA 1	118	90	55	22·5	16·35	12·20	1·07	0·92	D.C. series	600	4	1,350	7,750	33	56	87	Nose suspension	4·23	Motor generator field control		1		
	0216–7	2	4	0	AA — AA	90	90	45	22·5	11·65	7·84	1·07	—		600	4	500	6,600	13	56	180		4·23			1		
Pennsylvania R.Rs	32–3	2	4	4	2 B + B 2	150	95	57	23·7	19·85	17·05	1·73	0·92	D.C. series	600	2	2,130	8,000	72·5	129	70	Jack shaft side rod	—	Series-parallel	Shoes		—	Air
	10–31, 34–42	31	4	4	2 B + B 2	142	90	54	22·5	19·85	17·05	1·83	0·92		600	2	2,130	7,560	77	129	67		—					
	3951	1	4	0	AA — AA	88	88	43	22	11·88	7·95	1·42	—		600	4	630	9,000	19·2	65	139	Gearless quill	—			0		
	3931	1	6	2	1 C — C 1	234	199	116	33·1	23·35	19·52	1·83	0·92	3-ph. induc.	850	4	4,800	40,000	33	56	49	Geared jack shaft	5·05	Cascade	Pantographs	1		
	—	3	4	2	1 B — B 1	185	140	85	35	20·82	16·79	2·03	0·84	1-ph. series	335	4	3,300	26,800	34	56	56		3·9	Transf'r tappings		1		
Baltimore and Ohio R.R.	LE 1, 2	3	4	0	AA — AA	87	87	—	21·7	10·34	—	1·58	—	D.C. series	600	4	1,080	10,400	28	—	80	Direct gearless	—	Series-parallel	Shoes	0	—	Air
	6–9	4	4	0	AAAA	73	73	20	18·2	9·06	4·5	1·07	—		600	4	800	17,000	13	—	91	Nose suspension	4·3					
	11–12	2	4	0	AA — AA	84	84	30	21	12·05	8·34	1·27	—		600	4	1,100	11,300	26·4	72	76		3·2					
	13–14	2	4	0	AA — AA	91	91	29	22·7	12·05	8·34	1·27	—		600	4	1,100	11,300	26·4	72	83		3·2					
	15–16	2	4	0	AA — AA	109	109	29	27·2	12·05	8·34	1·27	—		600	4	1,100	11,300	26·4	72	99		3·2					
Grand Trunk Rly.	2655–60	6	3	0	AAA	60	60	28	20	9·01	—	1·58	—	1-ph. series	280	3	816	8,550	26	48	73	Nose suspension	5·3	Transf'r tappings	Pantographs	1		Air
Michigan Central R.R.	7500–05	6	4	0	AA — AA	91	91	29	22·7	12·05	8·34	1·22	—	D.C. series	600	4	1,100	15,800	19	64	83	Nose suspension	4·3	Series-parallel	Shoes	0	—	Air
	7506–09	4	4	0	AA — AA	109	109	29	27·2	12·05	8·34	1·22	—		600	4	1,100	15,800	19·8	64	99		4·3					Air
Boston and Maine R.R.	4000–04	5	4	2	1 AA — AA 1	118	93	54	27·7	14·75	11·75	1·60	1·07	1-ph. series	342	4	1,232	8,360	40	60	96	Geared quill	4·1	Transformer tappings	Pantographs	1		Air
	4005–06	2	4	2	1 AA — AA 1	121	98	54	24·5	14·65	11·75	1·60	1·07		342	4	1,232	8,360	40	60	98		4·1			1		
Detroit, Toledo and Ironton R.R.	—	1 (2-unit)	16	0	2 units (AAAA + AAAA)	318	318	—	20	35·70	31·60	1·07	—	D.C. series	600	16	4,200	42,600	26	56	76	Nose suspension	4·45	Motor generator field control	Pantographs (22,000 v., 25 ~)	2	Air	Air and regenerative

*Also work on direct current, 600 volts.

The axle arrangement was 1 AAAA 1; each driving axle carried a directly mounted armature, the bipolar field system being mounted on the truck. The 1-hour capacity of the motors was 550 horse-power each, and the non-spring-borne weight on each driving axle amounted to 5 tons, with 1·110 m. diameter wheels. This arrangement allowed of the quick dismantling of the motor by lowering the armature, complete with wheels, into a special pit. A single magnetic circuit sufficed for all the motors; the air gaps were 19 mm. on each side; enough to allow of vertical play between the poles and armatures. The results of two years' trial were satisfactory, and the N.Y.C. company ordered thirty-four locomotives of this type for the substitution of steam power in the electrified zone, which was completed in 1906–1907.

Early in 1907, however, a serious accident occurred to a train rounding a curve at high speed. The exterior rail of the curve in question was torn outwards. Suspicion was cast on the running gear of the locomotives. It was suggested that the lateral forces of the locomotives were excessive on account of the low centre of gravity. The official report repudiated this suggestion as to the cause of the accident, but an investigation of the locomotive's riding qualities at high speed was undertaken, the electric train speeds being meanwhile limited to 55 kilom. per hour on curves. Subsequently the following alterations were effected: the single Bissel trucks were replaced by two-axle bogies, making the axle arrangement now 2 AAAA 2. These were artificially loaded with heavy transoms; an unsymmetrical suspension at three points was devised, and the motor axles provided with boxes with spring-limited lateral play. These improvements were incorporated in twelve new locomotives built in 1908–1909, and the original thirty-five were converted. The new locomotives were provided with shields to prevent the attraction of fragments of iron to the field magnets. A diagram of the arrangement of these locomotives—known as Series S—is shown in Fig. 4; main data are given in Table III.

The Series T locomotives are of AA – AA + AA – AA construction. There are two main articulated chassis, each resting on a pair of axles and a two-axle bogie, all axles carrying gearless motors as in the "S" class. The two main chassis carry the cab supported on two pivots. The locomotives thus comprise eight bipolar gearless motors, each with a one-hour rating of 325 horse-power (forced ventilation). The two motors of a truck are connected permanently in series, and each such truck has its own single magnetic circuit. The control is of the familiar series-parallel type, there being nine notches for all four motor groups in series, eight notches for the arrangement of two parallel sets of two in series, and finally seven notches for all groups in parallel. Each motor group, as indicated, consists of two series-connected motors. Modifications in the running gear have been incorporated in later construction. The number of Series T locomotives is now twenty-six. Data are given in Table III. and Fig. 4.

There have recently been placed in operation seven 100-ton AA – AA locomotives for switching or shunting service, making a total of eighty electric locomotives in the electrified zone.

All the locomotives are equipped with third-rail shoes, and, in addition, short pantograph shoes are fitted above the cabs to collect current from "overhead third rails" which have been built at places where the trackwork is too complicated for the convenient use of the normally placed third rails.

Maintenance is centralised at Harmon, on the main Hudson division, with a small additional inspection shop at North White Plains.

5. Results of Electrification.

(*a*) *General.*—The N.Y.C. electrification has proved to be reliable for the extremely important services conducted. The electrified zone is, however, limited in extent, making for compactness in the general lay-out and avoiding anything in the nature of long-distance transmission. These conditions are suitable for the direct-current system; this, coupled with the uniformity of locomotive type, has led to very satisfactory results in maintenance and operation.

Table IV.—*Electric Locomotive Maintenance, New York Central R.R.*

	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.
Number of electric locomotives ..	74	74	74	74	74	74	74	74
Average locomotive weight, tons ..	108	108	108	108	108	108	108	108
Average weight on drivers, tons ..	82	82	82	82	82	82	82	82
Locomotive maintenance—								
Repairs, dollars	116,111	124,413	179,172	172,528	167,426	289,254	327,764	334,351
Depreciation, dollars	79,763	82,413	82,722	81,934	83,189	98,236	86,354	86,345
Locomotive-kiloms.—								
Freight revenue kiloms.	4,400	25,500	214,000	76,800	88,500	60,000	8,300	2,400
Passenger revenue kiloms.	1,878,000	1,980,000	2,103,000	1,989,000	2,023,000	2,136,000	2,215,000	2,334,000
Shunting revenue kiloms.	1,098,000	1,122,000	1,220,000	1,153,000	1,212,000	1,207,000	1,213,000	1,328,000
Mixed and special revenue kiloms.	300	—	100	—	—	—	40	—
Total revenue kiloms.	2,980,700	3,127,500	3,537,100	3,218,800	3,323,500	3,403,000	3,436,340	3,664,400
Non-revenue kiloms.	10,700	9,600	4,500	1,950	6,700	9,450	23,800	6,000
Total locomotive kiloms.	2,991,400	3,137,100	3,541,600	3,220,750	3,330,200	3,412,450	3,460,140	3,670,400
Maintenance per locomotive-kilometre, cents (excluding depreciation and retirements)	3·90	3·97	5·06	5·35	5·04	8·50	9·45	9·10
Maintenance per 100 tons on drivers, cents	4·75	4·84	6·17	6·53	6·15	10·35	11·50	11·10

(*b*) *Locomotive Maintenance.*—In Table IV., above, will be found a summary of maintenance costs for the main line locomotives during the years 1918–1925 inclusive.

(*c*) *Interference with Communication Circuits.*—In order to suppress interference with telephonic and telegraphic circuits caused by parasitic alternating currents in the direct-current circuit (due to tooth effects in the converter armatures) a resonant shunt has been used. This consists of a circuit containing sufficient capacity and inductance to resonate at the tooth-ripple frequency, and is connected across the bus-bars. The results have been satisfactory.

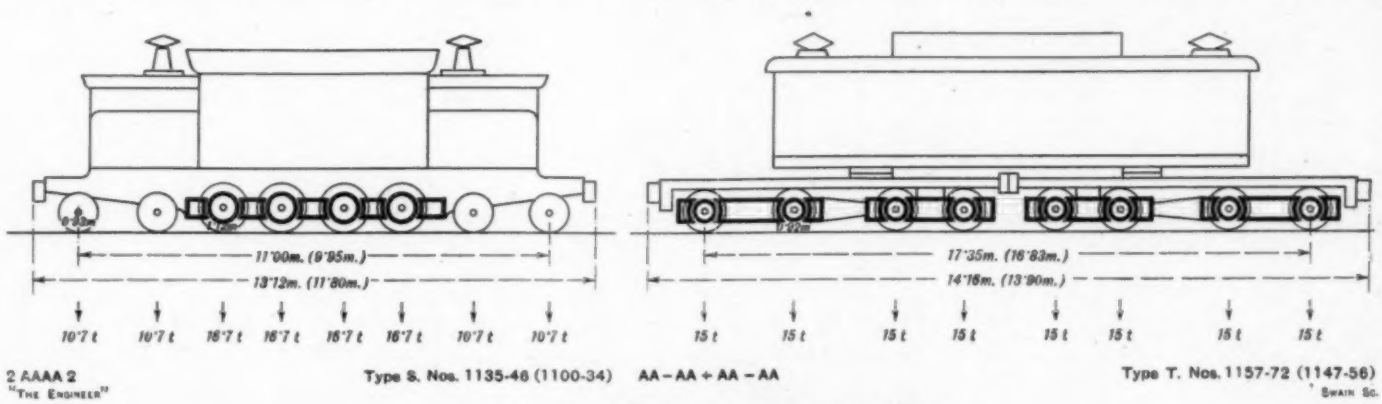


FIG. 4—NEW YORK CENTRAL R.R.—ELECTRIC LOCOMOTIVES

Institution of Mechanical Engineers.

On Friday evening of last week a meeting of the Institution of Mechanical Engineers was held in London for the purpose of hearing and discussing a paper by Mr. T. A. F. Stone, dealing with a method of classifying, analysing and comparing the characteristics of electric locomotives. At the outset of the proceedings, the President, Mr. William Reavell, announced that Sir George Goodwin had resigned his position as Vice-president, and that the Council, in recognition of the great services which he had rendered to the Institution, had elected him as an honorary life member.

In Mr. Stone's absence in India, Lieut.-Colonel Kitson Clark undertook the presentation of his paper. We reprint it in full elsewhere in this issue. Colonel Clark suggested that the scheme of classification proposed in the paper was not such an important aspect of Mr. Stone's work as the guidance which it would afford electric locomotive designers in the matter of determining whether a new engine agreed with or departed from average practice. Mr. Stone's estimation of the horse-power of steam locomotives was, he continued, based on a figure of 20 horse-power per square foot of grate area. He felt sure that that figure was an underestimate. By its adoption an injustice was done to the steam locomotive, and the comparisons throughout the paper were affected. Out of the ninety-two locomotives on the data of which the tables in the paper were compiled, it would be interesting to know how many were steam and how many electric. The author, he thought, should have taken cognizance of the fact that the steam locomotive, like the snail, carried its house on its back, while the electric locomotive left its house behind it, and only drew its fluid from it. Commenting upon the author's statement that the coefficient of adhesion of a steam locomotive was reduced by the action of the revolving balance weights, he stated that it was the practice of his firm to assume that the loss of adhesion from this cause varied between 1 and 3 per cent. The author's immediately succeeding remark was to the effect that the torque on the driving wheels of a steam locomotive varied during each revolution, whereas in an electric locomotive it was constant. It should, however, Colonel Clark remarked, be remembered that the steam turbine locomotive, of which one example was now under test on the London, Midland and Scottish Railway, gave a constant torque, and accordingly Mr. Stone's statement was strictly applicable only to the reciprocating steam locomotive. The horse-power to total weight ratio in the case of a steam locomotive was greatly affected by the class of line for which the engine was designed. For example, the curves encountered might necessitate the provision of heavy bogies, with the result that the ratio would be reduced without the horse-power being affected. This fact made sound comparisons difficult. Commenting on the curves given in Fig. 1, he called attention to the fact that they showed that the steam engine could take a train of diminishing statutory weight at a steadily increasing speed, but that the electric locomotive when its train load was reduced could only slightly or not at all increase its speed.

Professor W. E. Dalby agreed with Colonel Clark that 20 horse-power per square foot of grate area was too low. During some express trial runs on the London and South-Western Railway, 80 lb. of coal per square foot of grate were burned per hour. At 20 horse-power per square foot, such a figure meant that 4 lb. of coal were used per horse-power-hour, a value which was too high. At the St. Louis Exhibition trials eight locomotives averaged 3 lb. to 3¼ lb. of coal per horse-power hour. Again, 80 lb. of coal per square foot of grate area per hour was often exceeded. In the St. Louis trials the figure rose to about 130 lb. On the London and North-Western Railway six-coupled engines of the "Jumbo" class, with 17 square feet of grate area, often took 120-ton trains up the Shap incline at a good speed. Yet at 20 horse-power per square foot of grate, they would only have 340 horse-power to do it with, and he could not believe that it could be done. On the Great Western Railway a pull of 2 tons had been registered at 70 miles per hour with an engine having a grate area of 25 square feet. This performance bore no comparison with Mr. Stone's 20 horse-power per square foot of grate area. Dealing with the reduction of adhesion in a steam locomotive by the action of the balance weights, he pointed out that the reduction was produced only by that portion of the weights which was concerned with the balancing of the reciprocating parts, and that the amount of reduction increased with the speed. At low speeds, when the adhesion was required to be greatest, the reduction was practically zero.

Mr. J. D. Twinberrow said that the author was too optimistic in suggesting that the qualities of a steam locomotive could be gauged by the eye. There were as many deceivers on the railway as on the race-course. The American system of classifying engines according to their wheel base—as, for example, 0–4–4–0—was not satisfactory when applied to electric locomotives. The European system in which numerals were used to designate carrying axles and

letters to represent driving axles was preferable. For example, the "Pacific" 4–6–2 arrangement was represented by the symbols 2–C–1, or, alternatively, by 2–AAA–1 or 2–3 A–1. Dealing with the weight of equipment in steam and electric locomotives, he called attention to the fact that if a boiler were replaced by electrical units, which were not self-supporting, the rigidity of the complete engine would be affected. It was certainly true in American practice, and largely true in British, that the boiler contributed materially to the resistance of the engine to torsional and other stresses. A frame which was perfectly satisfactory for a steam locomotive might, when the boiler was replaced by electrical equipment, be too tender even to lift in the shops. Passing on to discuss the question of adhesion, he remarked that the slipping of the wheels was greatly affected by the height of the draw-bar pull above the axle. If that height were at all great, the front end of the engine might be lifted and the adhesion of the front wheels reduced. When a steam engine slipped, one knew pretty well what to expect, and do, but the slipping of an electric locomotive was quite a different, and a more important, matter.

Mr. J. O'Connor said that at first sight the paper looked somewhat formidable, but closer examination showed that it simply represented the tidying up of some old friends to make them more presentable in public. The rating of electric locomotives used by the author was the one-hour rating at full power. It ought, he maintained, to have been based on the average draw-bar pull at the average speed. The average ratio of the adhesive to the total weight of passenger electric locomotives was given by the author as 0·75. That figure was no doubt fairly correct for some express electric locomotives, but for many local passenger electric locomotives it was higher at from ·80 to ·90. In passing to goods electric locomotives, the ratio was not necessarily increased as the author suggested, for in some instances the change was made simply by altering the gear ratios without altering the motors or other equipment. The ratios given by Mr. Stone for the weight of electrical equipment relatively to the total weight were, he thought, too high. Instead of being something over 40 per cent., they ought to be about 33 per cent. In abstracting the weight of equipment, compressors associated with the brake gear should not, as was sometimes done, be included as part of such equipment. He thought the figure, 33·9, given for the horse-power per ton of total weight rather overstated the capacity of the three-phase locomotive.

Mr. A. E. L. Chorlton said that in the designing of Diesel-engined locomotives every problem had to be investigated anew, and therefore it would be very useful if simple general values, such as Mr. Stone gave, could be established for the leading factors. In an actual instance, it was estimated after considerable investigation that a Diesel engine of 600 horse-power would be required to meet the given conditions. The existing steam engine performing the work had a grate area of 20 square feet. If, therefore, the coefficient of 30 horse-power per square foot could be accepted, it would be possible to arrive at the power required in the Diesel engine by merely mental arithmetic. The paper, he said, laid no stress on the key factor of acceleration. On the question of adhesion, he remarked that in American practice the adhesion was taken at 33⅓ per cent. of the total weight, while in this country it was commonly not more than 500 lb. per ton, or, say, 22 per cent.

Mr. F. H. Livens remarked that the author had apparently based his calculations on the examples he had at hand. As regarded the steam locomotive figures, the quality of Indian coal might account for the figure of 20 horse-power per square foot of grate area, which the author had taken. In the recent Great Western–North-Eastern exchange trials, the Great Western engine, with a grate area of 30 square feet, developed 1800 horse-power, or 60 horse-power per square foot. The diagrams and particulars given in the paper were very misleading and should be revised.

Mr. Pendred pointed out that the 20 horse-power figure was an average value, not a maximum one, as Mr. Livens seemed to take it to be. It would not, he contended, be wise to reject Mr. Stone's figure rashly.

Mr. E. L. Diamond suggested that some reference should be made to the elaborate system of classification developed a short time ago on the London, Midland and Scottish Railway. That system was designed to enable the traffic department to determine how many trucks a given locomotive could haul to a given schedule. Mr. Stone's method did not help to answer such a question. Continuing, he remarked that a coal consumption of 130 lb. per square foot of grate area per hour was often exceeded, and that consumptions as high as 150 lb. had been registered. It was quite usual to find the horse-power developed at 30 to 40 per square foot of grate area. For steam shunting locomotives the author gave the ratio of the adhesion to the total weight at 0·701. There were, however, very few such engines in this country in which the ratio was not unity; that was to say, in which the whole of the weight was available for adhesion.

Mr. J. W. Sims thought it would be useful if the author would give the dates of the engines from which his data were taken. The electric locomotive was at present in a state of flux, and the particulars of such locomotives built within the past five years or so would be considerably different from those of ten years ago. It was not made clear in the paper what rating basis had been chosen for the electric locomotives. There were two possible ratings, the continuous and the one-hour. The author had apparently taken the one-hour rating throughout. What three-phase locomotives had been selected by the author for the purposes of his comparison? Were they those of the New York, New Haven and Hartford or the Norfolk and Western Railroad? The electric locomotives of these lines could not properly be called three-phase. They were really single-phase machines fitted with transformers.

Mr. T. Stephens also desired to know the identity of the engines tabulated, particularly of the electric locomotives.

Professor P. M. Baker said that it was not quite clear what the author meant by horse-power. Was it the limiting horse-power? Dealing with Mr. Livens' remarks, he stated that the North-Western Railway of India had some good steam locomotives, with superheaters, but the coal available was bad, its calorific value being about 10,000 B.Th.U.

Mr. P. C. Dewhurst held that the average value of the horse-power to total weight for steam locomotives, as given by the author, was very low. The figure for the steam goods engine was 5·7, but his experience showed it to be 10 to 12. That fact suggested to him that the steam engines used in the comparison were old-fashioned.

Lieut.-Colonel Kitson Clark, closing the discussion, remarked that if the author's formulæ were not quite satisfactory, they had at least proved provocative. The meeting showed that there were many defenders of the steam locomotive, and that the electric locomotive required many more expositors.

Models and Analogies for Demonstrating Electrical Principles.

No. XVI.*

In the *Electric Journal* of May, 1926, published by the Westinghouse Company, Mr. S. B. Griscom deals with a mechanical analogy to the problem of transmission stability. In the early studies of transmission stability, considerable difficulty was experienced in gaining an accurate conception of the problem owing to the number of factors involved and their relation to each other. Subsequent analytical work produced methods which were quite satisfactory for calculating system performance under different conditions of operation, but in these methods the phenomena taking place were masked in such a way as to make the physical interpretation difficult. The mechanical system of pivoted arms and springs described in the article was found to have properties closely analogous to the electrical characteristics of transmission systems, and it had the advantage of being more easily visualised.

In Fig. 133 is shown the vector diagram of a circuit of pure reactance, such as a transmission line in which the resistance is neglected. If the voltage and current at the receiver end are known, the supply voltage may be obtained by adding to the receiver voltage the voltage drop in the line, paying due regard to its phase position. The supply current in this case is the same as the receiver current. It should be noted that Fig. 133 is essentially a vector diagram of voltages; the current vector is added merely for the sake of completeness to show the known current. If the receiver current is omitted from the diagram, its value can readily be obtained from the reactive voltage drop vector, since the latter is the product of I_r and X.

The following equations express the relations between the various quantities for this circuit:—

$$E_s = \sqrt{E_r^2 + 2 E_r I_r X \sin\theta + I_r^2 X^2} \quad . . \quad (1)$$

$$I_s = I_r$$

$$\varphi = \tan^{-1}\left(\frac{I_r X \cos\theta}{E_r + I_r X \sin\theta}\right) \quad . . . . \quad (2)$$

$$P_r = E_r I_r \cos\theta \quad . . . . . \quad (4)$$

$$P_s = E_s I_s \cos(\theta + \varphi) \quad . . . . . \quad (5)$$

where—

E_r = magnitude of receiver voltage.
E_s = magnitude of supply voltage.
I_r = magnitude of receiver current.
I_s = magnitude of supply current.
θ = angle between receiver current and voltage.
φ = angle between supply and receiver voltages.
X = reactance of line.
P_r = receiver power.
P_s = supply power.

The vector diagram of Fig. 133 may be represented by a mechanical device—Fig. 134—in which the vectors for supply and receiver voltages are represented by the arms A and B, pivoted about the point O. The pins M and N correspond to the ends of the voltage vectors and are fastened to two blocks, which slide without friction in a radial direction along the arms. A spring S, the extremities of which are fastened to M and N, corresponds to the vector giving the voltage drop in the transmission line. This spring is assumed to have ideal characteristics; that is, it will contract to a point if no forces are applied to it. The device of Fig. 134 is shown as having forces applied at the points M and N, causing the arms A and B to be separated, the forces being necessarily in the same direction as the spring. The equations which express the relations involved in the mechanical device are as follows:—

$$D_s = \sqrt{D_r^2 + 2 D_r F_r K \sin\theta + F_r^2 K^2} \quad . . \quad (6)$$

$$F_s = F_r \quad . . . . . \quad (7)$$

$$\varphi = \tan^{-1}\left(\frac{F_r K \cos\theta}{D_r + F_r K \sin\theta}\right) \quad . . . . \quad (8)$$

$$T_r = D_r F_r \cos\theta \quad . . . . . \quad (9)$$

$$T_s = D_s F_s \cos(\theta + \varphi) \quad . . . . . \quad (10)$$

where—

D_r = distance from O to N.
D_s = distance from O to M.
F_r = force at N.
F_s = force at M.
θ = angle between F_r and the perpendicular to O N.
φ = angle between arms A and B.
K = extension of spring per unit of force.
T_r = torque at N.
T_s = torque at M.

Comparing equations (1) to (5) with equations

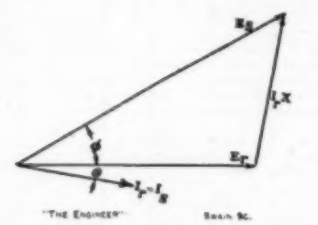


FIG. 133—REACTANCE VECTOR DIAGRAM

(6) to (10), and observing that for a line having uniformly distributed reactance, the conditions at any intermediate point may be obtained by using in the equations the value of reactance between that point and the receiver end, the following correspondence between the mechanical device and the vector diagram for the electrical system will be noted:—

(1) The radial distance from the pivot to any point on the spring corresponds to the voltage at the corresponding point on the transmission line.

(2) The length of the spring included between any two points corresponds to the voltage drop in the line.

(3) The spring tension is proportional to its length and corresponds to the current in the line.

(4) The product of the distance from the pivot and the component of spring tension at right angles to the radius vector at any point gives a torque which corresponds to the power in the electrical system at that point.

(5) The product of the distance from the pivot and the component of spring tension along the radius at any point corresponds to the reactive power at that point on the actual system.

(6) The angle included between any two points on the spring and the pivot corresponds to the phase

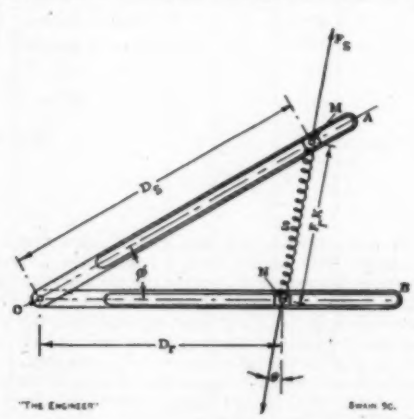


FIG. 134—MECHANICAL REPRESENTATION OF VECTOR DIAGRAM

displacement between the voltages of the actual line at those points.

(7) The angle between the current and voltage at any point is represented by the angle between the spring and the perpendicular to the radius vector at that point.

The mechanical device further shows by analogy some interesting details of the action of a transmission circuit joining two points of an electrical system, where the voltages differ both in magnitude and phase position. On the mechanical device these points may be M and N, and as these points are separated the spring must be stretched, creating a tension which tends to bring the points closer together. A similar effect is produced on the electrical system. When the ends of the line are connected to points of different voltage, the difference in voltage must appear across

* No. XV. appeared November 19th.

the line, causing a current to flow. This current is in such a direction as to tend to equalise the voltages, both in phase and magnitude, the extent of the change being dependent upon the size of the equipment tending to hold the voltages constant. Another point brought out quite clearly by the mechanical device is that transmission of reactive power is accomplished solely by differences in voltage magnitudes, while true power is transmitted solely by differences in voltage phase. This point is very important in connection with stability studies, since synchronous machines connected to a system are forced to follow any shift in phase of the line voltage at the point to which they are connected, which shift is opposed by their inertia.

Although the exact characteristics of synchronous machines are somewhat involved, they may, for the purposes of this discussion, be considered as having a constant internal E.M.F. and a fixed reactance between this generated voltage and the terminals. The internal E.M.F. may be considered as always having a fixed phase relation with respect to the field structure. With these assumptions, synchronous generators, motors, and condensers are identical, the only difference being the manner in which they are

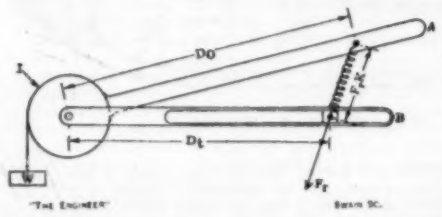


FIG. 135—MECHANICAL REPRESENTATION OF SYNCHRONOUS MACHINE

used, *i.e.*, whether or not power is supplied to or delivered by them. The vector diagram of a synchronous machine having these characteristics is identical with that of a transmission line having constant supply voltage, and may be illustrated by Fig. 133 with E_s constant.

The mechanical representation of a synchronous machine is shown in Fig. 135. The constant internal E.M.F. is shown by the fixed distance D_o on the arm A, the terminal voltage by the distance D_t on the arm B, and the leakage reactance drop by the distance F,K that the spring is extended. The fly-wheel I simulates the effect of the machine inertia in opposing changes in phase position, and the moment due to the weight W represents the power output or input, considered as counter-clockwise in the case of a generator. The equations for the transmission line apply to the synchronous machine, with the restriction that the supply voltage is constant.

The diagram in Fig. 135 is drawn for the general case in which the magnitude and phase position of

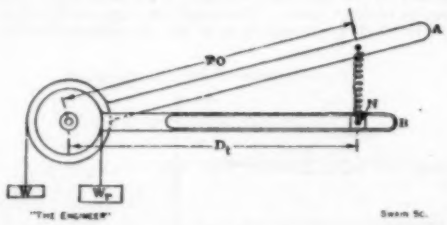


FIG. 136—MECHANICAL DEVICE REPRESENTING UNITY POWER FACTOR LOAD

the receiver current are known. Two other cases will be considered to show how the mechanical device will adjust itself to correspond to specific kinds of loading. Fig. 136 shows its appearance for a load of unity power factor. This load is simulated by applying a torque by means of the weight W_r to the arm B. The spring will extend itself to such an extent that its tension produces a torque on B sufficient to balance the moment due to W_r, which is, in turn, balanced by the moment due to the weight W. Since the block N moves without friction along B, it will seek a position where the direction of the spring is perpendicular to N.

Fig. 137 is drawn for a loading with a reactor

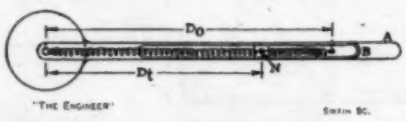


FIG. 137—MECHANICAL REPRESENTATION OF A REACTOR

across the generator terminals. The reactor has the characteristic of drawing lagging current in proportion to the voltage applied, which voltage, in turn, varies with the current drawn from the generator. The effect of the reactor may be produced on the mechanical device by a spring connecting the pivot to the point at which the reactor is connected—in this case, the generator terminals. The strength of the spring varies directly as the admittance of the reactor. That this spring corresponds to the reactor may be demonstrated by the fact that the tension toward the pivot, which is equivalent to reactive current, varies directly with the radial distance of the point of attachment from the pivot and tends to reduce this distance. The point N automatically adjusts itself to a position where the tension of the spring representing the reactor just equals that representing the generator reactance. The distance of the point N from the pivot then gives the terminal voltage of the generator for this condition of loading.

Figs. 136 and 137 show how the mechanical device automatically adjusts itself to the conditions of loading or to the characteristics of the system to which it is connected. An electrical power system is made up of a series of synchronous machines, connected together by means of transformers and transmission lines, each of which obeys certain laws. When the machines are interconnected, these same laws must be satisfied for each of the elements simultaneously. With the usual conception of the vector diagram, it is difficult to estimate the resultant conditions on the system, since it is necessary to know the electrical conditions at one end of a circuit in order to draw its vector diagram. With the mechanical equivalent, however, the various elements combine naturally to produce a result which can be readily visualised.

The way in which the mechanical device adjusts itself to correspond to any terminal conditions which may be applied is shown by Figs. 134 and 135. When these units are connected together, each one determines the terminal conditions of the other. Fig. 138 represents a system in which a generator is driving a synchronous motor through a pure reactance. The system is in equilibrium, the torque on the arm A

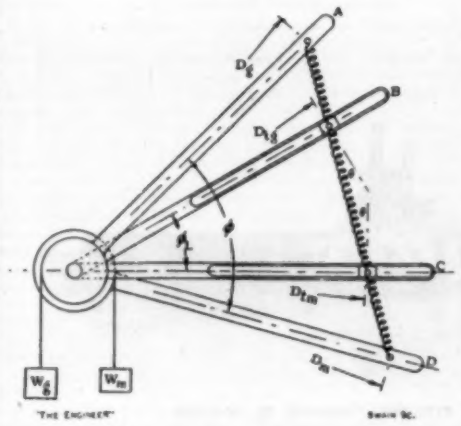


FIG. 138—MECHANICAL DEVICE REPRESENTING GENERATOR DRIVING MOTOR

due to W_g being transmitted by the springs to the arm D, just balancing the torque due to W_m. The magnitudes and phase positions of the terminal voltages of the generator and motor are represented by the lengths D_{tg} and D_{tm} and the positions of the arms B and C respectively, the motor terminal voltage being taken as reference. When no power is being drawn from the system except by the motor, all of the springs are in a straight line, the power factor being determined by the excitations and internal voltages of the two machines. The angle θ corresponds to the angle between the current and terminal voltages, and is the same for both machines for the case shown, in which the machines are identical and have the same internal voltage.

The system of Fig. 138 may be used to show why there is a limit to the amount of power which may be transmitted over a given circuit, and how the problem of stability arises. If the internal voltages of the two machines are maintained constant, and the weights W_g and W_m are increased slowly and proportionately, a readjustment will take place. The arm A will shift in a counter-clockwise direction and the arm D in a clockwise direction, increasing the angle between them and decreasing the distances D_{tg} and D_{tm}. The total stretch of the spring and the angle θ are also increased. Interpreted in terms of the electrical system, these changes show an increase in the phase angle between the internal voltages of the generator and motor, a decrease in terminal voltage, an increase in total current and a lowering of power factor. It is also evident from the figure that the spring tension increases with an increase in angle up to 180 deg.; but the torque corresponding to the product of the distance from the pivot and the component of spring tension at right angles to the radius vector increases up to 90 deg. only, beyond which angle it decreases.

The maximum power obtained in this manner is termed the power limit of the system for the internal voltage considered, and is obviously less than the power limit of any of the individual elements of the system. Its value depends upon the internal voltages of the machines and hence the excitation. With the vibrating voltage regulator commonly used, the excitation is increased as the load increases, tending to maintain a constant voltage at the terminals of the synchronous machines, up to the limit of the exciter voltage available. Whether the regulator is successful in maintaining constant terminal voltage, depends upon its speed and the rate of application of load. The latter is not solely dependent upon the loading of the motor, because of the motor inertia which momentarily supplies a portion of the increased load from its stored energy of rotation. In doing so, however, it must slow down, and introduce a phenomenon termed "over-swing," the effect of which is to impose an additional strain on the system, just as a suddenly applied mechanical load imposes a much greater strain on a member than does the same load applied gradually. Assuming that the load has increased so slowly that the voltage regulator has had ample time in which to build up the generated voltage, and that no overswings take place, the limit of the system under consideration will be reached when the line angle φ_L is 90 deg., as shown in Fig. 139. It should be noted that the internal voltages of the

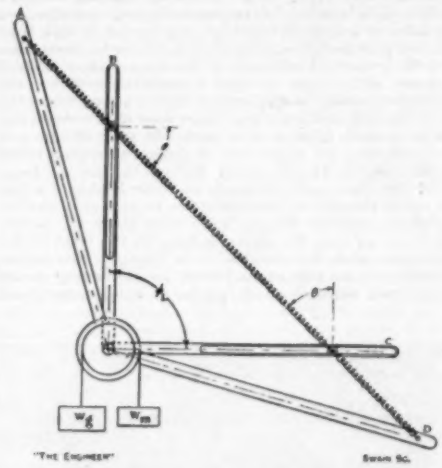


FIG. 139—MECHANICAL DEVICE SHOWING LIMITING CONDITIONS

machines are considerably higher than those shown in Fig. 138. The maximum power attained under this condition of constant terminal voltage may be termed the "theoretical static stability limit," and is the absolute limit of power that can be transmitted over the system. This value can never be reached in practice, however, owing to the finite speeds of the voltage regulator and load increments. Furthermore, it is assumed that the machines at the terminals of the line are able to generate internal E.M.F.'s high enough to maintain their terminal voltage, a condition not always possible in practice. The practical "static stability limit" of a system will, in general, lie somewhere intermediate between the two limits described, namely, that in which the internal E.M.F.'s are maintained constant, and that in which the voltages at the terminals of the connecting lines may be kept constant. On large systems where the inertias are high and the load diversified, the operating limit will be close to the "theoretical static stability limit"; on small systems, the lower inertias and more fluctuating loads will cause the operating limit to be closer to the limit imposed by constant internal voltage.

The foregoing discussion of Figs. 138 and 139 shows that the actual operating limit depends upon the speed with which changes of loading and excitation can take place, even though the definition of the limit is prefixed by the term "static." In actual practice, however, certain operations and occurrences, such as line switching and short circuits, impose sudden changes on the system which make the consideration of excitation speed and inertia effects of prime importance. Even though actual operation may demonstrate that a system is capable of transmitting a certain amount of power under steady conditions, it may be entirely inadequate to deliver this power continuously when subjected to a line-switching operation or a short circuit. This point may be brought out more clearly by comparing the electrical performace of a transmission line with its mechanical performance. A tower which would have ample strength to support its lines in fair weather might be completely wrecked when loaded with sleet and subjected to strong winds. To guard against this possibility, the towers are designed conservatively to withstand the worst conditions that may be encountered. It would, of course, be impracticable to provide enough margin in the electrical capacity of a system to ensure uninterrupted service under all conditions, but conservative operation of a power system requires that the design be adequate to prevent interruptions from the more frequent and less severe disturbances to which it is exposed.

It is beyond the scope of the present article to describe in detail the effects produced on a system by the various disturbances or to discuss the remedial measures which may be applied to give a reasonable resistance against them. In the next article a typical case will, however, be considered which possesses

all the elements necessary to the application of the principles involved, and a general description of its action will be given which should permit a similar study of other cases.

An American Train-Ferry Steamer.

No. I.

TRAIN ferries or car-transfer steamers, as used extensively by American railways, are of three general types: —First, steamers of low freeboard, with nothing above the track deck except light superstructures to house the machinery and quarters and to support the navigating bridge with its large pilot house; secondly, steamers of high freeboard, like ocean-going ships, but with the stern cut off square above the track deck and left open to allow of running the cars in and out of the hull; thirdly, barges handled by tug boats.

Vessels of the first class are used mainly on the rivers, where navigation conditions are comparatively easy, and the water is smooth. They are usually of the side-wheel or paddle-wheel type, with engines of various designs. In a few cases electric interurban railways, operating on both sides of a large river, have car ferries of this type driven by petrol engines, and of such size as to carry from two to four cars. The boats of the second class, almost invariably with single or twin screws, are used on the Great Lakes, where violent storms, high seas and heavy ice have to be reckoned with, and there may not be much sea room in crossing from port to port. In such storms and with a following sea there may be danger of a ship being pooped, owing to its open stern. In fact, the loss of a large boat of this class with all hands on Lake Michigan a few years ago is thought to have been due to such an accident. As a result, various designs have been made for water-tight doors to close the stern opening to the level of the upper decks when the vessel is on its voyage. The barges are employed mainly at harbours, as in moving goods wagons from railway goods yards to local water-front

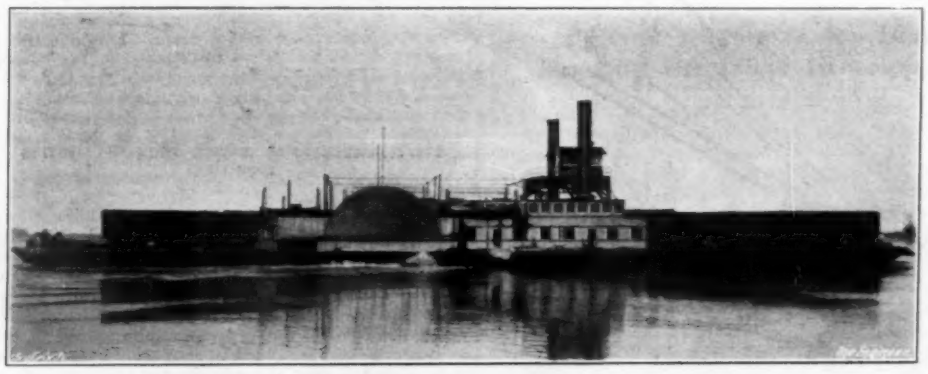


FIG. 1—THE PADDLE-WHEEL TRAIN-FERRY STEAMER "GEORGE H. WALKER"

yards or wharves. They are used to some extent also at river crossings.

On the lakes and in harbours where the changes in water level are slight, an adjustable hinged bridge, with hinged apron at the outer end, suffices to adjust the level of the rails of the shore tracks to that of the tracks on the boat. The outer end of the bridge is suspended usually from an overhead frame by means of cables. On rivers, however, where the range from low water to flood level may be very considerable, this plan is impracticable. To meet this condition, an incline with lines of rails is built down the bank and in general parallel with the current, extending well below the low-water level. On the rails rides a cradle or long timber carriage supported by numerous small wheels and having its deck either level or with a slight upward gradient to the outboard end. On the deck is a line of railway, having its rails connected to those on the incline by means of tapered or feather-edged rails which ride upon the incline rails. By means of a cable and winding engine, the cradle is moved up or down the incline, so that its outboard end will be level with the train ferry's deck at any stage of water in the river.

One of the latest examples of a paddle-wheel train ferry for river service is the George H. Walker, designed and built by the Dravo Company, of Pittsburg, for the Gulf Coast Railway. This railway extends up the east bank of the Mississippi River from New Orleans to Baton Rouge, where train ferry connection is made with Anchorage, on the west bank. Beyond this point the railway extends to the Mexican frontier, a distance of 750 miles from New Orleans. As the two landings are not directly opposite, the ferry route is about 6 miles in length. A view of the steamer is given in Fig. 1, with an elevation and deck plan in Fig. 2.

The George H. Walker is 346ft. long overall, with a moulded beam of 56ft., and a width of 91ft. 6in. over the deck, which is extended to the outboard faces of the paddle boxes. This deck overhang is supported by cantilever brackets on the hull. The moulded depth beneath the track deck or train deck is 11ft., and the draught with a full train load is about 6ft. The deadweight of the vessel in service is about 1200 tons. Inclined engines geared to the paddle shafts give a speed of about 12 miles an hour in still water with a full train load.

Three tracks or lines of rails along the deck provide a carrying capacity for eleven long sleeping cars and passenger coaches, or twenty-three goods wagons, averaging 42ft. overall. Cars enter at the bow instead of the stern, the deck having a square end with an inclined projecting apron which is supported by cantilever brackets on the hull and engages with the landing stage or cradle, so as to hold the boat in position. Two lines of rails on this bridge register with two lines at the bow of the boat, but these latter lines diverge and are both connected with a middle track. The three tracks extend to the extreme stern end of the deck, where heavy steel buffer frames are attached to the track rails in such a way that the weight of a car running against the buffer stop helps to resist any tendency of the buffer frame to yield under shock.

Hull Construction.—The flat-bottom hull, with only one

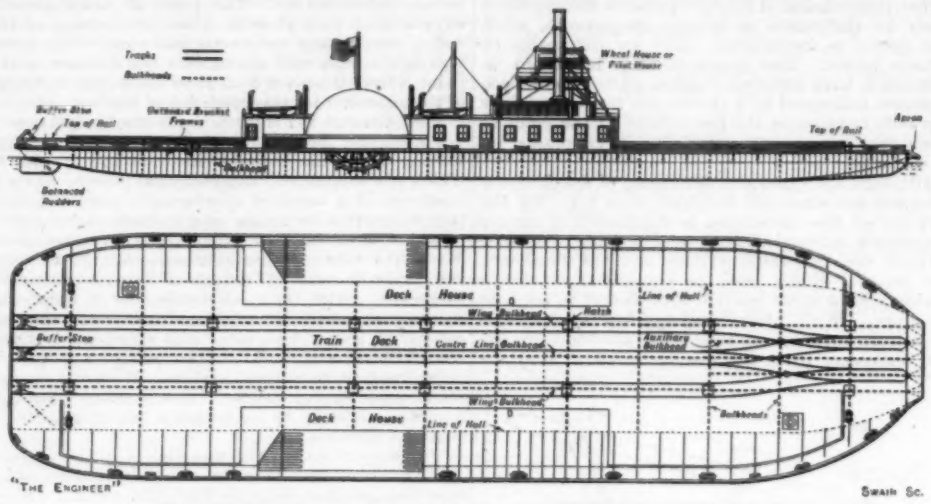


FIG. 2—ELEVATION AND DECK PLAN OF THE "GEORGE H. WALKER"

deck—as shown in Figs. 2 and 3—is subdivided by a centre-line longitudinal bulkhead, extending the entire length of the vessel, and by thirteen transverse bulkheads, so as to form twenty-eight water-tight compartments. Two of these compartments are also made oil-tight to serve as bunker tanks for fuel oil. In addition, there are two longitudinal wing bulkheads, one under each of the outer lines of rails, the middle track being supported by the centre line bulkhead. These wing bulkheads, which are not made water-tight, are of the intercostal type, framed between the transverse bulkheads. The deck has a transverse camber or crown of 8in.

Steel plating, $^{7}/_{16}$in. thick, is used for the bottom, sides and bilge. It is put together with double-riveted end laps, except that the bilge has double-riveted double butt straps. All seams are double riveted.

Bulkheads.—The continuous centre line water-tight bulkhead is of $\frac{3}{8}$in. plate, with double 6in. by 3in. bounding angles at top and bottom. The transverse water-tight bulkheads are of $\frac{3}{8}$in. plate with stiffeners of 6in. ship channels spaced 26in. between centres, but the ends of the stiffeners are not connected, except in way of the fuel oil tanks, where they are fully bracketed at top and bottom.

Each of the two longitudinal intercostal wing bulkheads, which are not water-tight and which support the deck under the two outer tracks, is of $\frac{3}{8}$in. plate between the deck and floor beams, with top and bottom angles, and connected to the transverse bulkheads by double angles.

Hull Reinforcement.—To support the outboard bearing of each paddle wheel shaft, a heavy plate girder is carried on the ends of the cantilever brackets under the guards. This girder is of $\frac{3}{8}$in. plate, with an 18in. rolled channel laid flat in inverted position on the top boom and stiffened by an 8in. by 6in. angle on the inner leg of the channel. The bottom boom is composed of two similar channels, laid with webs horizontal and back to back, so as to form an H section. To carry the inboard bearing there is a box girder, having $\frac{7}{16}$in. and $\frac{3}{8}$in. web plates, with $\frac{5}{16}$in. cover plates supported by stiffeners of ship channels. The paddle boxes, which are built into the superstructure, are of 20ft. radius, with $\frac{3}{8}$in. bulkheads and cover plates. The outboard bulkhead is of $\frac{3}{8}$in. plate in front of the shaft girder, and $\frac{7}{16}$in. above that level. Additional support for the deck overhang of the guards at the machinery and boiler rooms is provided by four transverse truss rods or "hog rods"—two at each paddle box, and by two heavy pipe struts at each boiler-room.

In the hull construction all holes were shop punched to full size, and the parts were assembled and bolted together in advance of riveting. There was little or no reaming of rivet holes. The caulking edges of the plates were bevel sheared, and those of the oil-tight angles were bevel planed. Rivets in deck, shell and oil-tight bulkheads were countersunk, with their points raised slightly above the flush. Steel hatches fitted with ventilating gratings give access to the hold compartments. Drainage of the hull is provided for by steam syphons, one to each compartment, with independent overboard

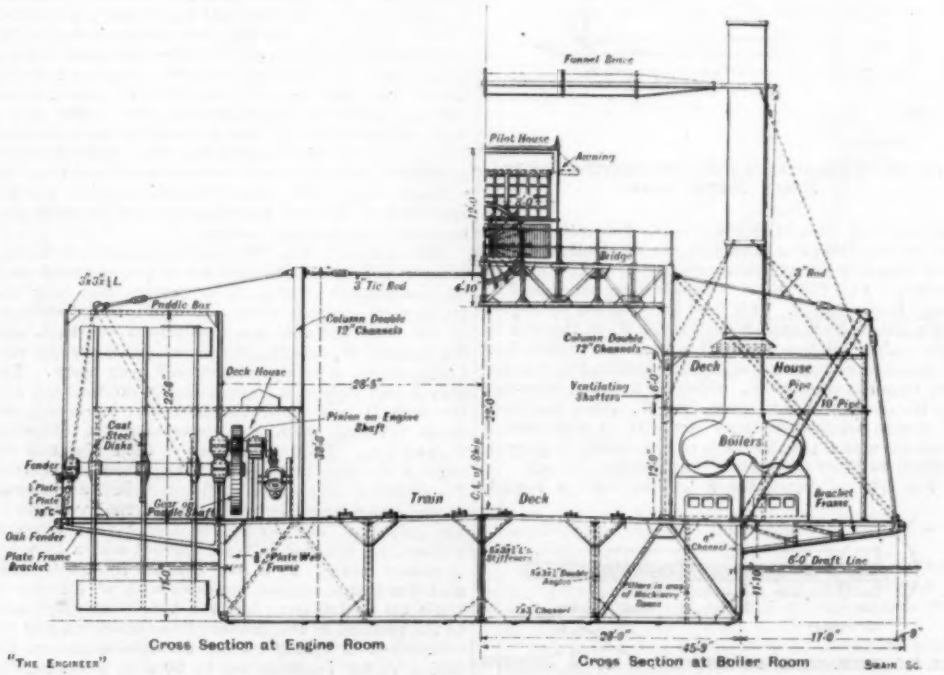


FIG. 3—CROSS SECTIONS OF THE "GEORGE H. WALKER"

discharge, and with the valves arranged in batteries.

Superstructure and Bridge.—The superstructure consists of two deck houses about 38ft. apart, one along each side of the track deck and extending over the guards. They are 50ft. to 25ft. wide, with a height of 12ft., or 18ft. at the boiler-rooms.

The navigating bridge, which spans the space between the deck houses, is about 27ft. long, supported by a pair of lattice trusses, 4ft. deep, which are carried by columns seated over the hull frames. Beneath these columns the frames are reinforced by trussing, which distributes the load over the floor beams—as shown in Fig. 3. These columns are pairs of 12in. rolled channels braced together and having knee braces and bracket plate connections. The bridge deck, about 27ft. above the rails on the track deck, is of ⅜in. plate riveted to a framing of 6in. channels.

The pilot house or wheel house is of the large and commodious type characteristic of American river steamers. It is of wooden construction, 16ft. by 18ft. in plan and 12ft. high, with its floor 2ft. 6in. above the bridge. Large windows with rolling sash are provided, and there is the usual arrangement of sunshades over the windows and canvas awnings at the sides.

The interior communication system includes a mechanical telegraph to each engine-room, bell signals between the engine-rooms and firing-rooms, between the pilot house and the main capstans, and between the pilot house and the crew's quarters. Speaking tubes lead also from the pilot house to each engine-room and to the clerk's office.

Rudders and Capstans.—There are two balanced rudders each having a 12in. pipe for rudder stock, with two ⅜in. plates placed on opposite sides of the pipe and brought together at each end to fit a tapered forging. On the bottom are fins of angles 6in. by 4in. Stops are provided to limit the arc of travel or swing to 37½ deg. on each side of the centre line of rudder. Each rudder post passes through a water-tight tunnel to extend above the deck. The weight of the rudder is taken by step bearings of the ball-bearing type on top of the trunk, while at the bottom of the trunk is a cast steel bearing.

On the head of the rudder stock is a cast steel spider fitted with a quadrant of 6ft. radius, and having an arc of travel of 37½ deg. on each side of the centre line. A forged steel worm engaging with a bronze worm wheel bolted to the quadrant is driven by a two-cylinder reversing engine controlled from the big steering wheel in the pilot house by means of levers and bell cranks. This engine is sufficiently powerful to throw the rudders from hard-over to hard-over while the vessel is going astern under full headway. For emergency use, a relieving tiller may be shipped on the quadrant and operated by block and tackle led to the after capstan.

Two double-purchase steam capstans are arranged on the starboard side forward and on the port side aft. Each has a 13in. barrel or drum and is driven by bevel gears from an engine placed below the deck and having two cylinders, 6in. by 6in.

Railway Tracks.—The tracks on the train deck are laid with 85 lb. flange rails bolted to cast steel saddles or chairs, which, in turn, are bolted to the deck beams. The gauge is 4ft. 8½in., but widened to 4ft. 9in. on the curves by which the three tracks converge to two tracks at the bow. To check movement of the cars while the boat is crossing the river, the tracks have an ascending gradient at each end, with a rise of 15in. at the bow and 24in. at the stern. Here each rail is carried by a steel box girder tapering from the height of the rail chair to the height above noted. At the bow the forward end of each box girder has a V-shaped projection to engage the apron of the landing stage or cradle, and thus hold the rails in line. Between these girders is a floor or false deck level with the bottom flanges of the rails. Strong buffer stops are placed at the stern ends of the tracks, as already noted.

CONFERENCE ON TAR.

A Conference on Tar is to be held under the joint auspices of the Coke Oven Managers' Association, the Institution of Gas Engineers, and the Society of Chemical Industry (Fuel Section and Manchester Section) today in the College of Technology, Sackville-street, Manchester. There are to be three sessions, morning, afternoon and evening.

At the morning session held at 10 a.m. the following papers will be presented (in abstract) for discussion:—(*a*) "A Study of Tars and Oils Obtained from Coal," by Mr. F. S. Sinnatt and Dr. J. G. King; (*b*) "A Plea for Standardisation of Analytical Methods in Coal Tar Products Specifications," by Mr. W. Gordon Adam; (*c*) "The Viscosity of Tar," by Mr. H. M. Spiers; and (*d*) "The Consistency of Bitumen Mixtures," by Mr. H. M. Spiers. At the afternoon session at 2 p.m. the following papers will be summarised and discussed:—(*e*) "Notes on Vertical Retort Tar," by Mr. J. McLeod, in collaboration with Messrs. C. Chapman and T. A. Wilson; (*f*) "The Production of Road Tar from Vertical Retorts," by Mr. Michael Barash; (*g*) "The Influence of Carbonising Conditions upon Free Carbon Content of Tar," by Mr. H. Hollings; and (*h*) "Tar from Steamed Vertical Retorts," by Dr. Albert Parker. At the evening session at 5 p.m. the following papers will be considered:—(*i*) "Tar from the Point of View of the Highway Authority," by Mr. W. Gordon Adam, in consultation with Mr. H. W. Robinson; (*j*) "Coal Tar Disinfectant," by Mr. A. C. Tait; and (*k*) "The Evaluation of Pitch," by Mr. H. F. Taylor.

According to report received from the American Consul at St. John, Canada, comparatively high-grade copper ore has been discovered by recent prospecting near Elgin, Albert County, New Brunswick, the preliminary examination covering an area of approximately two square miles. According to official assays the ore value runs as high as 15 dollars per ton. Shafts have been sunk over the prospected area and copper ore discovered in every instance, in most cases from within 16in. of the surface and as far down as diggings were made.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE ELECTRICITY BILL.

Sir,—As I am no longer able to take part in debates, will you permit me to express my views upon the most astounding Bill I have ever read? When a measure of first-class importance is suddenly evolved, searching inquiry into its credentials is essential. The Electricity Bill is so technical in some aspects that the daily Press cannot adequately deal with it, and the public, confused and uninstructed, may be driven to accept statements which have no relation to facts.

The other day the report of the Electricity Commissioners on Electricity Supply was published, which proved to the hilt that this great private enterprise, in which over £100 millions of capital are embarked, is progressing in the most satisfactory manner, judged by any test that can be applied. This unfortunately can be said of few British industries at the present time. Legislation has already dealt disastrously with electricity in this country; but there have been some relaxations recently which are enabling the lighting companies especially to come together with economic advantage.

In these circumstances, we are threatened by a measure of a kind unknown in any other country which will infallibly cause huge expenditure, spread confusion among existing undertakings and mark a tremendous stride in the direction of Socialistic nationalisation. How has this become possible?

The Weir Committee made a report which, without further formal inquiry, was accepted with some modifications by the Government. This Committee was manifestly incompetent to devise a measure of this magnitude, involving highly complex and debatable technical questions; but, as a judicial body, it might have been able to judge the merits of proposals laid before it by experts. The evidence taken by the Weir Committee has been withheld from the public! It did, however, rashly adopt a number of statistics disparaging to the British industry and based on comparison with other countries, where totally different conditions prevail. I cannot ask for space to explain why these comparisons are false and misleading.

The main contentions of the supporters of the Bill appear to be that:—

(1) By the erection of super-stations immense economies can be realised. The elimination of small inefficient stations is steadily proceeding, and the super-station is not necessarily economic, while it introduces certain risks.

(2) Government control alone can ensure development on a huge scale which would cause new industries of many kinds to spring into sudden existence wherever cheap electricity could be made available. This theory ignores experience. As industries spring up, private enterprise provides them with electricity, but power is frequently a very small factor in the economy of a factory. The price that the supporters of the Bill expect to reach in 1940 is greater than is now charged by some undertakings, which will further reduce their prices long before that date.

(3) By setting up a "grid" or "network" of high-power transmission lines all over the country a great impetus will be given to agriculture. The term "grid" is used in two quite different senses by the supporters of the Bill, with the result of a confusion of ideas, which I cannot here explain. The long high-voltage transmission lines on the Continent have arisen because local sources of power, such as water and lignite, are at a distance from industrial areas. They have no correspondence with the "grid" as popularly imagined, which could only operate at a heavy loss.

(4) Government action is essential to secure standardisation of frequency. Standardisation within limits is desirable, but it is a luxury which our impoverished country cannot at present afford. The accepted estimate of cost is wholly fallacious.

The machinery set up by the Bill is un-English and grotesque—except from the Socialist point of view. A Board—Soviet—of eight appointed by the Ministry of Transport is to be the executive body. It must have been intended that this Board should be composed of experts in electrical engineering, as it was originally empowered to draw up schemes for the approval of the Electricity Commissioners. This was changed by the House of Commons, and the latter are to prepare schemes for the approval of the Board. We thus have a diarchy, with confusion of responsibiliy, as the crown of the administrative edifice. The powers of the Board are enormous. It can compulsorily purchase the whole output of a "selected station" at cost price—a most debatable figure—and force the owners to purchase back at a price loaded with the expenses of the Board. It can order the owners "to operate the station so as to generate such quantity of electricity at such rates of output and at such times" as it may direct, thus assuming practically managerial powers over company undertakings. If the owners of the selected station cannot comply with these directions, or are unable to raise the capital required for the changes entailed, the Board can take over and work the concern, subject to the approval of Parliament. Clause 5 embodying this arrangement may evidently prove confiscatory, as may Clause 14, which gives power to close any generating stations declared to be producing at a higher cost than that at which the Board, financed either by the consumer or the taxpayer, claims to supply electricity.

Such are the principal provisions of a Bill which permits interference with private enterprises to an extent hitherto unknown outside of Russia. The finance of this huge Government business is nebulous to the last degree. The Board may borrow 33½ millions at once—and as much more later as Parliament may approve—under Treasury guarantee. The burden of interest must fall either upon the consumers or the public, at least until such time as the Board is able to show large profits, which are problematical. The Bill thus constitutes a step into the unknown, and it is certain only that one of our greatest and most progressive enterprises will be thrown into confusion.

The country as a whole may be said to be backward in the use of electricity, as compared with those countries where water power is available, though some districts can fearlessly compare with any areas abroad. There would have been greater progress had it not been for hampering legislation. With the shocking example of the effects of Government interference with the coal industry staring us in the face, may not private enterprise, to which our past prosperity is wholly due, demand that the heavy hand of Government shall not be laid upon electricity? Under the Bill, Government ownership of private undertakings can and will be enforced. It will then be a short step to the compulsory acquisition of the whole, and in the Star Chamber which the Bill proposes to set up, a Socialist Government would have at its disposal the necessary machinery, without further legislation.

Sydenham of Combe.

November 23rd.

SOUTHERN RAILWAY FOUR-CYLINDER LOCOMOTIVE.

Sir,—In the last paragraph of the article on this locomotive in the current issue you observe that the reciprocating forces are not balanced equally in the wheels on both sides of the engine. An analysis of the balancing shows, as stated in the article, that the unsymmetrical angular arrangement of the cranks necessitates a difference between the balance weights in each wheel. Analysis of the diagrams for the revolving weights and reciprocating weights separately shows that for the leading and intermediate wheels some of the forces tend to counteract one another more on the right-hand side of the engine than on the left. This also applies to the reciprocating forces. Hence the difference in the magnitude of the portion of the balance-weight in the wheels which causes hammer blow.

Another reason for some of the differences between the balance-weights is that the revolving parts of the valve gear have been balanced, and these parts are not in the same relative positions to the cranks for both sides of the engine. Their effect in the leading wheels is that the magnitudes of the balance weights are reduced a little. By neglecting these parts, it would be possible, in certain types of engines, to make the pair of wheels on each axle the same, but a variation in rail pressure would occur, in addition to that caused by the part of the balance weight due to the reciprocating forces.

In the tables at the bottom of page 559, the distances measured to the left of the left-hand reference plane should be considered negative, and consequently the corresponding mass moments will be negative.

P. W. Bollen.

Whitley Bay, November 20th.

PILE DRIVING.

Sir,—While examining the relative differences in formulæ given by various authorities on pile driving data recently, it came to my notice that some engineers vary the factor for penetration or "set" dependent upon the way the pile is driven, by a drop hammer or steam hammer, *e.g.*, one formula is stated to be $L = \frac{12\,WH}{D + 0{\cdot}1}$ when L = ultimate load in tons; W = weight of hammer in tons; H = fall of hammer in feet, and D = penetration average for last few blows in inches, when a steam hammer is used.

Another formula is $\frac{L = 12\,WH}{D + 1{\cdot}0}$, where the hammer is an ordinary drop or monkey.

I am anxious to ascertain what theory is involved in this, as I presume the only difference between the use of a steam hammer and a drop hammer is, when using steam, the successive blows are delivered much more rapidly than when using the windlass type. Is there any difference in the ultimate effect?

November 22nd. Monkey.

[The formulæ quoted by our correspondent are of American origin, and are known as the "Engineering News" or Wellington's formulæ.—Ed. The E.]

A CLEARING HOUSE FOR SOURCES OF INFORMATION.

Sir,—As a result of successful conferences which have been held annually for the past three years, the Association of Special Libraries and Information Bureaux has been formed and is now in process of incorporation. The Council cordially invites the support of all organisations and bodies, commercial houses, industrial concerns, &c., which attach adequate importance to the collection, treatment, and dissemination of information relevant to their work.

The new body will act as a channel through which any inquiring member may be put into direct touch with the source of information required. With the generous assistance of the Carnegie Trust, A.S.L.I.B. has in preparation a Directory of Sources of Specialised Information in the British Isles; a copy of this will be sent free to each member, as soon as available. In addition, it is hoped to establish, by co-operation between interested parties, unified policies with respect to abstracting, cataloguing, indexing, filing, &c.

Membership is open to all interested bodies, and a small subscription of £2 2s. per annum has been fixed. Further details, including a form of application and a list of members, will be furnished by the Secretary, 38, Bloomsbury-square, London, W.C. 1. To ensure its establishment on an adequate scale not less than 500 members are required by March, 1927.

(On behalf of the Council of the Association of Special Libraries and Information Bureaux),

London, November 22nd. R. A. Gregory.

A Commercial Slide Rule.—Our attention has been called to a new slide rule known as the "Commerce" rule, which John Davis and Son (Derby), Ltd., All Saints' Works, Derby, have just placed on the market to facilitate calculations involving money and weight. The rule carries the usual A B C and D scales, and is equipped with the usual cursor. On the slide between the B and the C scales there are engraved two equally divided scales. The lower of these scales, like the log scale on the reverse side of the slide of an engineer's rule, is divided into ten major portions, each of which is subdivided in tenths and fiftieths. The upper scale is equally divided into twenty portions, each of which is subdivided into halves, quarters, twelfths and twenty-fourths. The two scales by direct reading from one to the other, and without movement of the slide, enable any sum involving shillings, pence and halfpence to be converted into a decimal fraction of a pound or *vice versâ*. In addition, by using the shilling marks on the upper scale as cwts. and the three-pence marks as quarters, any expression involving cwts. and quarters can be converted into a decimal fraction of a ton or *vice versâ*. Once the decimal conversion has been made the calculation is conducted on the A and B or the C and D scales in the ordinary way, reconversion of the decimal portion of the answer being subsequently effected by the reverse use of the two equally divided scales. Since the lower of the two equally divided scales is simply the ordinary log scale transferred to the front of the slide, the rule lends itself to calculations involving compound interest. We understand that the rule can be supplied to deal with units other than the pound sterling and the ton,

The Manufacture of Files at Templeborough Works, Sheffield.

By J. W. WALKER (Works Manager).

No. I.

Introductory.

The following notes have been compiled with the object of briefly describing the various materials and processes which are at present employed in file making. The subject is so wide that it is impossible to cover in detail all the interesting problems which arise. These notes deal with the main points only, and it is not pretended that they are conclusive or complete. The processes described and the machines illustrated are those in general use at the works of Sheffield Steel Products, Ltd., situated at Templeborough, Sheffield, in the centre of the file-making industry. This plant is capable of producing upwards of 10,000 dozen files in a normal working week, the quantity varying of course with the size and type of the file being manufactured. The firm embraces three of the oldest established file businesses in England, and is well provided with the craftsmen necessary to produce all classes of files of the finest quality.

It is hoped that the notes may be rendered clearer by the accompanying illustrations, and that they may be sufficiently lucid to present an intelligent idea of the processes involved.

Steel: Its Various Grades and Compositions and the Economic Problems in Relation Thereto.

Steels used in the manufacture of files may be divided broadly into three classes: (*a*) Siemens open-hearth steel; (*b*) crucible steel; and (*c*) alloy steel. Of these three classes that most generally employed is open-hearth steel, this being due to its proved suitability and relatively low cost. This steel has the additional advantage that it can be made in large quantities to any required analysis, and can be rolled—free from roaks and surface defects—into bars of suitable section for the manufacture of any type or size of file. On the other hand, the analysis of crucible steel cannot be controlled to the same extent because of the relatively small ingots produced.

The analysis called for so far as the Templeborough works of Sheffield Steel Products, Ltd., is concerned lies within the following limits:—

Carbon	1·2 per cent to 1·5 per cent.
Silicon	·1 per cent to ·3 per cent.
Manganese	·3 per cent to ·6 per cent.
Sulphur	Not exceeding ·05 per cent.
Phosphorus	Not exceeding ·05 per cent.

It is customary to make the smaller sizes and smooth cuts of files from the higher carbon steel, and larger sizes—say, 12in. and upwards—from the lower carbon steel. Crucible steels having approximately similar analyses are also used, but not to the same extent by reason of their higher cost. In some quarters it is claimed that crucible steels possess better lasting properties, but it cannot be said that opinion is unanimous on this point.

The third class of material mentioned is, generally speaking, Siemens or electric steel of similar analysis, but containing, in addition, small proportions of other elements, such as tungsten, chromium, and cobalt, varying from ·5 per cent. to 3 per cent. Files made from steels falling in this category are usually termed by their makers "high-speed files," but it is extremely doubtful whether there is any increase in their actual efficiency as cutting tools. The properties of a file are governed by the skill with which the various manufacturing processes are carried out, rather than by the class of material used.

Experiments have been carried out with the object of substituting mild steel for the other classes of material, the files so produced being subsequently case hardened. Such files have never been made on a commercial scale, the cost of case hardening and other factors ruling them out of consideration.

Forging and Heating: Tanging, Rolling, Boss Work and Semi-automatic Processes.

Up to fifty years ago practically all files were hand forged, but at the present time machine methods are employed almost exclusively. The methods carried out at the Templeborough works follow the latest practice, and many improvements have been and are being introduced. More uniform blanks are produced by machine forging than is possible by hand. Blanks are first tanged under a belt-driven power hammer, the remaining operation of forming the point being carried out in various ways, depending on the type of file to be forged—see Figs. 1, 2 and 3, and Figs. 6 and 7, p. 582. Files of rectangular section usually have their points rolled. For this purpose a pair of specially designed excentric rolls is employed, each roll being fitted with an adjustable steel die that can readily be removed for repair or renewal. On the same machine is fitted a squeezing device which enables the operator readily to produce files having points of any required width, shape, or taper. The pressing anvils are also adjustable so that work can be produced to fine limits, and they can also be readily changed. This method of rolling is also being developed for point rolling other sections besides rectangular, *e.g.*, half-round, three-square and square sections, have already been produced by this method chiefly in the larger sizes. Smaller sizes are more economically forged by other means.

The usual method of forging the points of half-round and three-square files in Sheffield differs materially from this rolling process. Belt-driven power hammers with tups varying from 28 lb. to 150 lb. in weight and capable of giving from 500 down to 250 blows per minute are commonly used in the process. The varying sections of half-round or three-square file points are formed by the use of movable bosses or dies, which are controlled from the chair on which the forger is seated. The movement of the boss enables the forger to bring any particular part of the point under the face of the hammer, the force of the blow being controlled by a foot treadle. Considerable skill is necessary both in the production and use of these bosses and drawing tools in order to obtain really high-class work. Small files are produced by a method rather different from that just described. The boss for forging small files is usually fixed instead of movable. An alternative method is the employment of the drop stamp and trimming press instead of the power hammer, fixed dies being used in this method of forging.

Many automatic and semi-automatic devices have been designed and applied largely on the production of small three-square, square, and round files with the objects of reducing to a minimum the degree of skill necessary, and also of speeding up output. About twenty hammers at the Templeborough works are fitted with such devices to enable semi-skilled labour to produce a greater output than the most highly skilled forgers could attain on this particular class of work without such apparatus.

It is particularly desirable in working high-carbon steel such as is used in the manufacture of files to avoid excessive temperature, and it may be stated that if the forging temperature exceeds 950 deg. Cent.

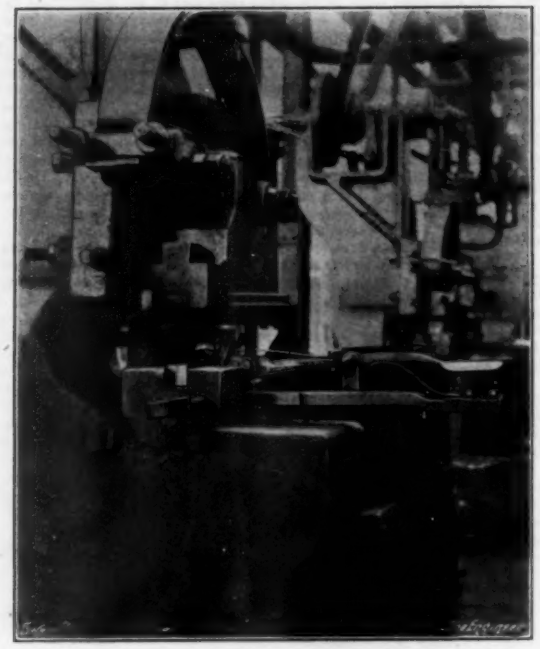


FIG. 1—BELT-DRIVEN POWER HAMMER

FIG. 2—FORGING—EXCENTRIC ROLLS, WITH SQUEEZING DEVICE

FIG. 3—FORGING—POWER HAMMERS AND TOOLS

the structure of the steel will be seriously impaired, the fracture of the finished article being coarse and crystalline, and the files becoming extremely brittle and unreliable in use. Heating furnaces may be coke, oil or gas fired, whichever may be most convenient for the particular locality. At the Templeborough Works a well-equipped modern water gas plant has been installed, and furnaces having suitable burners and mixers have been designed to heat the blanks for files in an efficient and economical manner.

ANNEALING AND STRAIGHTENING: FURNACES, TEMPERATURE, DE-CARBONISATION.

The object of annealing the forged blank is to take out all the uneven strains due to the unequal heating and cooling which may have occurred and to make the material soft and ductile, in order that the cutting operation may be carried out efficiently. The main essentials to be observed in this process are :—

(1) Gradual heating.
(2) Maintenance of correct and uniform annealing temperature for a sufficient period of time thoroughly to soak the whole contents of the furnace.
(3) Gradual cooling.

The pitfalls to avoid are (*a*) excessive oxidation and (*b*) de-carbonisation. There are many types of furnace designed for annealing, employing all the known methods of heating—that is, coal fired, coke fired, oil fired, gas fired—and also there are resistance furnaces heated electrically. It is not the purpose of these notes to discuss the various types, but to describe that in use at Templeborough—see Fig. 4. This furnace is gas fired, and consists of a long rectangular body divided into three chambers, the pre-heating chamber, the heating chamber, and the cooling off chamber. A track is laid along the whole length of the furnace to enable a cast iron table, supported on balls, to be easily rolled from one compartment to the other. From 10 cwt. to 20 cwt. of files can be placed upon each table, and continuous output is obtained.

In starting up it is usual to heat the furnace from cold with the table of files in the heating compartment. The temperature is raised to 700 deg. to 730 deg. Cent., depending on the carbon content, at which temperature it is maintained for an hour. The dampers are then raised and the table moved into the next compartment for cooling off, the table occupying the pre-heating chamber being moved into the heating compartment, a further tray taking its place in the pre-heating chamber, and so on. The average Brinell hardness after this treatment is between 180 and 210, and it is found that the file cutter has no difficulty in working with material at that degree of hardness. As in most gas-fired furnaces, it is essential that the annealer should so regulate the mixture of incoming gas and air as to prevent either undue oxidation—that is, scaling—or, on the other hand, de-carbonisation. In practice, it is found that, with the type of furnace described above, what little skin surface, if any, may be de-carbonised, is easily removed by the subsequent grinding operation, and it is rare indeed that files are found to be imperfect on that account.

Another important factor to be considered in annealing files is possible distortion. It is obvious that, if the files are not supported on a true surface along their whole length, when subjected to the heat necessary for annealing, they will readily bend and twist, the consequent straightening after cooling causing unnecessary labour. Naturally, too, the straightening operation would have detrimental effects on the blank, as it is obvious that the heavy blows required to straighten a badly distorted blank would cause an uneven hardness at the point of impact of the hammer, which would lead to unevenness in cutting and might even cause damage to the cutting chisel.

GRINDING: MACHINE AND HAND, SANDSTONE AND ABRASIVE WHEELS.

The primary object of grinding is to remove the outer skin of the forged blank which may be either oxidised or de-carbonised, and which, in any case, is too rough and uneven for the subsequent operation of cutting. Grinding was formerly carried out entirely by hand, natural sandstones being employed. The grinder was seated on a "horsing" situated above the centre of the axis of the stone, the top of the stone being rotated in a direction away from the operator. The more arduous part of the work is now carried out on grinding machines, and only such irregular parts

FIG. 4—FILE-ANNEALING FURNACE

as the extreme points of half-round and other special shapes are hand ground—see Fig. 5 and Fig. 8, p. 582.

The special type of machine employed at Templeborough is one manufactured at the firm's branch establishment, the works of Messrs. Oxley Brothers, Mowbray-street, Sheffield. The machine comprises two heavy cast iron brackets supported on a cast iron base plate. These brackets form supports for the bearings of the axles which carry natural sandstones varying in diameter from 3ft. to 4ft. 6in. when new. Provision is made for wearing down to approximately 15in. diameter. The speed of rotation can be quickly altered to give the same periphery speed, irrespective of the varying diameters of the stones; and there is a device which enables the operator quickly to race or true the stone.

The files are supported on a trough-like table, which is automatically reciprocated to and fro beneath the grindstone, the files being immersed in water to dissipate the heat generated during the grinding operation. Flexible supports are provided for the work, so that inequalities of forged blanks will not damage the stone, excessive pressure causing these supports to give slightly, the pressure between stone and work being thus kept approximately constant. The reciprocating table is carried on rollers, provision being made by means of former-plates to enable the various shapes of tapered or bellied files to be produced in a definite and uniform manner, the former-plate automatically regulating the height of the table, and thus maintaining the correct relative position of the work to the grindstone. These plates can be quickly changed, but where large output is required it is usually possible to keep one machine on a particular class of work, thereby saving the time necessary to change from one shape to another. In addition to the rotary motion, a slight lateral motion is transmitted to the grindstone, so as to cause it to move across the work with a short reciprocating motion. This motion has the effect of causing the face of the stone to wear more evenly, and also prevents deep grit marks from appearing on the ground surface of the work.

FIG. 5—GRINDING MACHINE WITH FILE BLANKS IN POSITION

The methods of grinding at present employed, both hand and machine, are now undergoing close scrutiny. Efforts are being made to replace the natural grit stone by abrasive wheels, and it may safely be predicted that in ten years' time or so natural stones will be extremely rare. The change is desirable on health grounds alone, it being a well-known fact that sandstone wheels are considered to be the main cause of grinders' fibrosis.

The practical advantages which may accrue from the change are :—

(1) Greater uniformity of finish, which would be an advantage for all classes of files.
(2) Smoothness of finish, which is essential for all single-cut and also for second-cut and smooth double-cut files.

Experiments are being made with the object of designing a special machine for carrying suitable abrasive wheels of various grit, grade and size for the different classes of files manufactured at Templeborough.

The Cornish Tin Mining Industry.

A BRIGHTER future for the tin mining industry in Cornwall was predicted in his presidential address recently delivered to the Cornish Institute of Engineers at Camborne by Mr. G. C. Cann, general manager of the Geevor Mine, who said that the Institute planned to make an immediate effort further to assist in the resuscitation of the Cornish mining industry. Some of the members of the Institute, he continued, knew from actual experience the increasing difficulties of winning tin in the Federated Malay States, owing to the exhaustion of the richer deposits. Many more thousand acres of the lower grade had to be worked to produce the same amount of tin as in former years, and it was only necessary to cast the mind's eye over the enormous area that had to be worked every year to come to the conclusion that the life of the tin fields for cheap working was a comparatively short one. The search for new tin fields had not brought to light, up to the present, any tin-producing areas that could be operated profitably to increase the reserves of tin ore to any great extent, therefore when it came to a higher cost of producing tin from the alluvial deposits, they were no longer a serious competitor, and the mineral wealth of Cornwall would eventually attract the serious attention of financiers to the production of tin in particular, and perhaps of arsenic and wolfram.

With regard to the future price of tin, Mr. Cann said that he thought they were all far better historians than prophets, but if the production were limited and the demand kept even to its present level, there was every reason to suppose that the present price of the metal would be maintained. That being so, Cornwall certainly offered the best prospects for profitable mining that he knew. Further, it was only necessary to make more widely known the extensive improvements in mining in general and milling and concentrating in particular, which had been made during recent years in the Cornish mines, for the necessary capital for justifiable mining enterprises within the county to be far more easily obtained.

The plants in Cornwall for the concentration and dressing of tin ores were more economically worked and far more efficient in the recovery of black tin than any other plants he had seen elsewhere. The present outlook with regard to tin mining in West Cornwall was much brighter than it had been for a number of years. The Geevor Mine in particular had responded extremely well to the heavy demand required for capital expenditure. It had a very good ore reserve. At Levant Mine a new lode had recently been cut at the 160 fathom level, and since then Levant had risen on this lode from the 160 to the 130 fathom level. The latter had been extended and intersected the same lode and recently connected with the rise. The lode was a large one, and its value appreciably above the average of the mine; in fact, it had such a strong appearance that exploration work had just been commenced at the 170 fathom level with the object of intersecting the lode at that point.

There were new mining activities in the Redruth, Camborne and St. Agnes areas. Some of the companies were re-working mines and others were busy on the exploration of fresh channels. They wished these companies complete success, because such operations gave confidence to the investor and ultimately a new lease of life to the Cornish tin industry. The coal crisis had dealt a very severe blow to Cornish mining, having offset the profits there might have been owing to the very high cost of coal. In addition, the mines had to reduce their operations because sufficient supplies of fuel could not be obtained. It was, however, fortunate that they had a public electricity supply, as the company which furnished it was in a far better position to carry large stocks of coal and obtain fresh supplies than any individual mining company. So far as his knowledge went there had not been any lack of electric power during the whole of the crisis, and electricity had to be considered a great economic factor in the working of the mines.

SOME very interesting evidence as to the facilities already afforded by the railway companies concerned has been given before the London and Home Counties Advisory Committee that is inquiring into the transit conditions in South London. In his evidence Mr. Frank Pick, the managing director of the London Underground Railways, said that the Baker-street and Waterloo Railway, now terminating at Elephant and Castle, could be extended with advantage to Camberwell-green, but that would not be useful to South-East London without a detour which would not be its natural line of advance.

Fairlie-Perkins Super-pressure Locomotive.

THE drawings below show the Fairlie-Perkins articulated locomotive. It will be seen that the boiler was situated mid-way between the two groups of wheels, as in the modern "modified Fairlie" or "Garratt." In view of the recent attempts to use turbines in connection with condensing plant on locomotives, this early, 1872, condensing locomotive is of unusual interest, the more so that the weight of the condensing plant is not carried on a separate tender but on the coupled wheels where this added weight is essential for adhesion. By the condensation of the steam, these locomotives were designed to overcome the difficulty of water supply on railways crossing deserts of the character of the Trans-australian scrub or serving parched sub-tropical mountain districts. The ordinary superheater single-expansion locomotive consumes from ¾ to 1 ton of water per hour for each 100 indicated horse-power, or 10 tons for each 1000 indicated horse-power, but the Fairlie-Perkins engine was intended to run for days together with only slight additions of distilled water to make up for accidental leakages.

For obvious reasons a compounding was adopted, but the high-pressure and low-pressure cylinders were combined in one, one end being about one-sixth the volume of the other—low-pressure—end.

This "modified Fairlie" locomotive was patented in 1872 by Robert Francis Fairlie, of Westminster, conjointly with Loftus Perkins, of King's Cross, and comprises the features patented by Fairlie in 1864, 1865, 1867 and 1869, together with the three patents by Loftus Perkins in 1870. The vehicle and all its articulations are by Fairlie.

The important feature of the design was the boiler, which, owing to its compactness, permitted a great reduction to be made in the total length of the engine, or, for an equal frame length, allowed of the introduction of an extra pair of driving wheels. Differing from all articulated locomotives invented since the Semmering competition, it was practically double-ended, both ends being the same, the driving footplate always being, in both running directions, in the centre, with the chimney over the middle of the cab roof, so that the smoke, products of combustion, service steam, &c., would not interfere with the visibility of signals and of the road, or incommode the enginemen during the passage of long up-hill tunnels. The footplate extended around the boiler, and the engine could be driven from either side by means of convenient dual levers, &c.

Compared with the "Mallet" articulated locomotive, there is a simplification in the total absence of the long articulated low-pressure steam pipe, high-pressure to low-pressure; for in the Perkins engine this steam passes direct from the front of the cylinder to the back of it, so dispensing even with a receiver. The reversing gear was designed to be operated by hand wheel, the movement of which was converted into another at right angles, through two bevel gears, operating the screws for the gear in both groups of engines. On both sides of the boiler were pivoted very long regulator levers which might latch—apparently at the driver's option—in a screwblock operated by a fine-pitch screw and hand wheel for giving particularly find gradations of throttle opening in connection with the extra-high-pressure steam when starting the engine, but apparently free to be operated by the lever alone in emergencies or for stopping. This detail is of interest from the fact that double throttles for a boiler pressure of only 350 lb. have been introduced for the boilers, also having water-tube fire-boxes, in the new two-cylinder compound engines recently reintroduced by Mr. Muhlfeld on the Delaware and Hudson Railway, the pilot throttle operating to reduce the steam pressure upon starting. After starting the second lever deals direct with the full steam pressure. Of the two, the Perkins arrangement appears simplest; but at present we have no record as to its efficiency in safely starting locomotives with a boiler pressure of 700 lb.

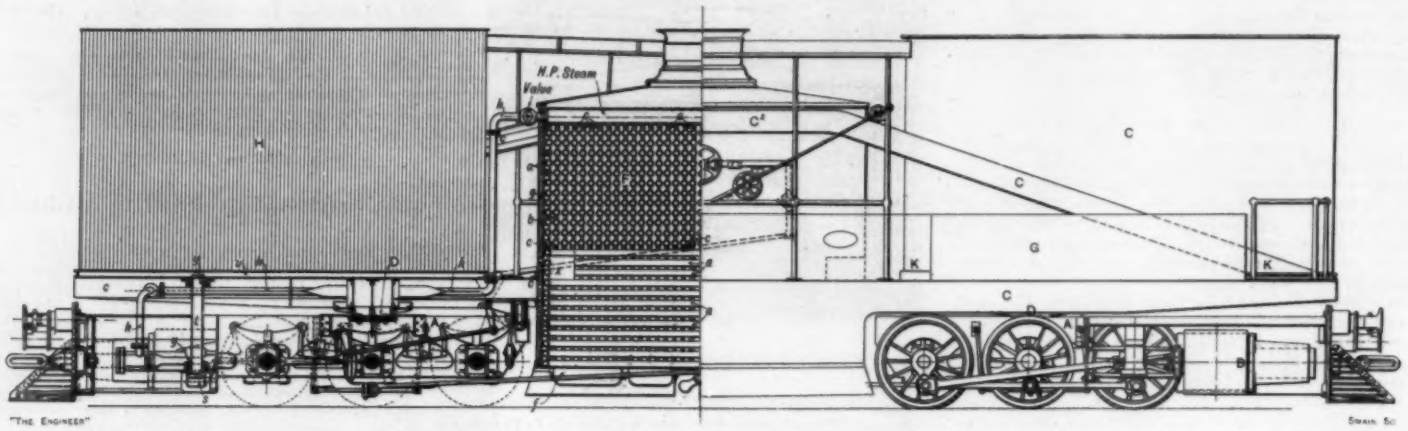
From the steam pipe the boiler steam is admitted by the small piston valve *m* into the principal valve chest O, through the orifice *n*, where the piston valve O^1 admits the steam by the inner edges of its front cavity into the high-pressure steam port *p* and *q*, and so into the high-pressure end of the tandem cylinder at *i*, whence the steam exhausts by *q* and *p* into the rearmost cavity of the piston valve, and thence into low-pressure port *r* behind the piston *l* in the low-pressure cylinder *k*. By this arrangement, of necessity single-acting, the maximum steam pressure is reduced to about one-sixth before it comes into contact with the stuffing-box; while the low-pressure exhaust is at atmospheric pressure when it comes into contact with the gland of the piston valve rod. In consequence, the glands only support a pressure of about 100 lb., instead of 700 lb., and the chance of cylinder leakage, so important in a locomotive fed from the condensate alone, is minimised. From the low-pressure exhaust the steam is released by the outside edge of the piston valve through the large port *s* into the vertical steam pipe *t*, which is articulated—as shown in the longitudinal section—and terminates in the foundation of the condenser. The latter is formed of very fine vertical pipes, and is air cooled, the condensed water falling into the foundation collector *v v*, whence it returns to the tanks under the footplate and into the hot-well from which the boiler is fed.

Since the engine was designed to work condensing, a blast could not be used, but provision was made for cases requiring forced draught, to fit valves allowing a part of the exhaust steam to be used for blowing, and therefore obliging the locomotive to carry extra water besides that needed to replace leakages. Small coal bunkers are provided on the footplate; the fire-hole in the angle of the fire-box is formed by cutting short three of the longitudinal tubes, which in all other rows surround the fire-box completely.

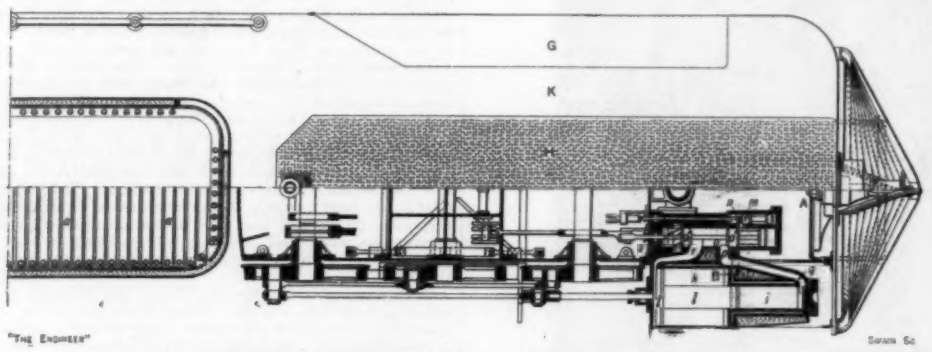
In the drawings it will be observed that the piston valve is of the type adopted in the most advanced modern practice, with large port areas, while the ports are voluminous and with easy curves to prevent wire-drawing—quite a modern lay-out fifty-three years ago. The cylinders are shown steam-jacketed, and also very effectively clothed in thick asbestos coverings. For the conservation of heat throughout the whole of the operation by the steam, there is no parallel in locomotives to the design here shown. Thus, the high-pressure piston-rod never comes into contact with the cool outside air, while that of a modern high-pressure locomotive passes one-half its working life in the outside air, and during the other half helps to cool the steam.

No oil was required with the Perkins piston and valve rings, and there was no oil to create trouble in the condenser and boiler feed water. Perkins rings were extremely hard, and in some cases were said to outlive cast iron rings, although by many reports the latter lasted longest.

C. R. K.



FAIRLIE-PERKINS LOCOMOTIVE—LONGITUDINAL SECTION AND ELEVATION



FAIRLIE-PERKINS LOCOMOTIVE—PLAN IN ELEVATION AND SECTION

BRITISH STANDARD SWITCHGEAR EQUIPMENTS FOR D.C. CIRCUITS.

A REPORT just issued by the British Engineering Standards Association deals with British standard switchgear equipments for direct-current circuits for pressures not exceeding 660 volts, and is divided into the following sections:—

I. Direct-current feeder equipments for single, two and three-wire service, employing circuit breakers for overload protection.

II. Direct-current feeder equipments for single, two and three-wire service, employing fuses for overload protection.

III. Direct-current generator equipments for two and three-wire service.

IV. Direct-current rotary convertor equipments for two and three-wire service.

V. Paralleling voltmeter equipments.

The publication gives in tabular form full details of the standard equipment, together with the optional equipment which may be used in certain cases. In addition, a diagram is given for every type of circuit covered by the specification, showing in symbolic form the lay-out of the equipment. There are in all forty such diagrams, covering the ground in a very comprehensive manner. These diagrams illustrate very strikingly how it is possible to combine the British standard symbols—as given in B.E.S.A. publication No. 108 and as shown in the latest decisions of the International Electro-technical Commission—into a comprehensive diagram.

Copies of this new publication (No. 194, 1926) may be obtained from the British Engineering Standards Association, publications department, 28, Victoria-street, S.W. 1, price 1s. 2d. post free.

THE INSTITUTION OF CHEMICAL ENGINEERS.

THE Institution of Chemical Engineers has arranged for a conference to be held at the Science Museum, South Kensington, on Wednesday, Thursday and Friday, December 8th, 9th and 10th next.

The conference will be opened on the Wednesday by the holding of a Council meeting at 3 p.m. Then there will be an evening session, beginning at 5.30 p.m., when a paper on "The Measurement of Mechanical Power Absorbed by Driven Machines: A Recording Torsion Dynamometer," by R. G. Parker and D. N. Jackman, will be presented.

On the Thursday there will be two sessions, 3 p.m. and 5.30 p.m. respectively, when there will be a symposium on "Statistical Methods in Relation to Industrial Efficiency." The following papers will be read:—(*a*) "The Control of Chemical Plant Operation by Statistical Methods," by Douglas Rider and T. Campbell Finlayson; (*b*) "Statistics in Industry—Some Uses and Limitations," by H. C. Marris; and (*c*) "Statistical Methods in Connection with Plant Construction," by E. Cooke.

On the Friday there will be an afternoon session, 3 p.m., when the following paper will be presented:—"Researches on the Laws of Air Elutriation," by Dr. Geoffrey Martin; and an evening session, 5.30 p.m., when the following paper will be considered:—"Refrigeration in Chemical Manufacturing Processes," by H. M. Dunkerley.

Railway Matters.

THE East Indian Railway authorities have fitted up many of their through and local trains with side-lights. Their object in providing these lamps is to check running train thefts as well as to light the station platforms when the trains stop at night.

IN announcing that an additional exit is to be provided at Golders Green Station, the Underground Company states that when that station was opened less than twenty years ago the number of passengers was less than 1000 per day; now it is 40,000 a day.

A DIAGRAM, issued by the Great Western Railway Company, shows that while the price of household coal delivered in London has risen from 48s. per ton to 85s. per ton, the railway charges remain the same, and that the percentage of rail rate to the delivered price has fallen from 18·75 to 10·59.

THE ingenious ticket-issuing and change-giving machine that has been on trial for six months at the Mansion House Station of the Underground Company has given such satisfaction that twenty-five others are to be tried on the system. It is said that 52 per cent. of the passengers on the Underground require change.

As a general rule lifts on the Underground Railways have been or are being replaced by escalators. There are, however, certain stations where the shafts are too deep for escalators. Such places are Holborn and Leicester-square. There the speed of the lifts is to be accelerated and they will travel at 290ft. per minute instead of 180ft.

WE regret to hear of the death of Mr. W. H. Oates, the manager of the Cheshire Lines Committee's railway. It was only in February of last year that he succeeded Mr. Charnley. We find no little satisfaction in the fact that the *Railway Review*—the N.U.R. organ—says that Mr. Oates "was in personal touch with all the men and, as chairman of the sectional council, earned the respect of all by his fair methods."

IN making an announcement that it is about to spend eight million dollars on automatic signals and automatic train control, the Pennsylvania Railroad Company points out that it was the first to adopt interlocking of points and signals and to use the block system. The latter was done about 1863 and the former about 1870. All the 14,355 miles on which passenger trains run are controlled by the block system.

IT was announced in this column on August 13th that, included in the further conversions from steam operation to electric traction on the Southern Railway, was the joining up of the line that now ends at Sutton to the Raynes Park–Dorking section at Epsom. It is now announced that in connection therewith a new station is to be built—presumably at the junction—which will dispense with the Epsom Town Station on the former Brighton system.

THE first refrigerator car in China has recently been put in service on the Shanghai-Nanking Railway. This is one of the twenty-one refrigerator cars ordered from Belgium by the Ministry of Communications. Nine of these cars are to be appropriated for use on the Tientsin-Pukow line, five on the Shanghai-Nanking line, four on the Peking-Mukden line, and three on the Shanghai-Ningpo-Hangchow line. The cars have each a loading capacity of about 22 metric tons; empty weight is about 30 metric tons.

A NUMBER of wealthy oversea merchants of Fukien, China, are planning the organisation of a provincial railway company, to be known as the Fukien People's Provincial Railway Company, Ltd., for the construction of railways in the province. Eleven prominent merchants are promoting the scheme, and it is reported that 3,600,000 dollars has already been subscribed by three of the promoters. The first enterprise of the company will be the construction of a railway from Changchow to Lungyen and operation of the mines along the line.

ALTHOUGH it is some years since the conversion of the Melbourne suburban railways to electric traction was made, the cost of the work done by Mr. C. H. Merz has, according to the *Industrial Australian*, never been revealed. Mr. Merz spent fourteen years in planning and supervising the suburban railway electrification scheme, and in the work employed a large technical and expert staff. The cost of this service is contained in the report of the Victorian Auditor-General. This item shows that Mr. Merz received the huge sum of £221,167 10s. 4d. For actual out-of-pocket expenses and fees Mr. Merz received £214,349. Additional payments were made to him on account of subsidiary and bulk supply schemes, £1770, and for reports on automatic signalling and other fees, £5049. The report also states that the cost of conversion to June 30th, 1926, was £6,424,167, of which £6,212,913 had been charged to loan funds and £211,254 to revenue.

ACCIDENTS of a similar type to that which occurred at Rawmarsh on Friday last, to which reference is made on our Journal page, are very rare. During the present century there has been only one fatal case of the kind, and that was at Kirtlebridge, on the Caledonian Railway, when, on April 6th, 1906, a wagon on an up goods train failed and led to the down line being fouled and the down afternoon corridor train ran into the *débris*, causing the death of a youth. There have also been three non-fatal such accidents, viz., at Ely on September 26th, 1905; East Fortune, N.B.R., on November 1st, 1906; and Waleswood, G.C.R., on October 16th, 1907. Mention may also be made of the collision of a passenger train with a wagon derailed during shunting at Newark on September 6th, 1915, when a child was killed. For a serious accident from a similar cause to last Friday's we must go back to Penistone, on January 1st, 1885, when the axle of a privately owned wagon broke and caused the opposite line to be fouled. A collision with an excursion train followed and four passengers were killed. The derailment of a wagon after a collision was the cause of the Chelford disaster of December 22nd, 1894, when fourteen passengers were killed, and, as at Newark, mentioned above, the derailment of a timber wagon during shunting operations at Wrawby on October 17th, 1908, caused eight lives to be lost.

Notes and Memoranda.

A MACHINE for harvesting sugar cane has been invented by Mr. R. S. Falkiner, of Brisbane, and is being used on this season's crop. It has a capacity of 40 tons an hour.

A CASTING weighing as much as 90 tons was recently made by the Brightside Foundry Company for an anvil block. It is said to be one of the largest anvils ever made.

THE Ruths steam accumulator which has been constructed by the Fairfield Shipbuilding and Engineering Company, Ltd., Govan, to the order of Fairfield-Howden Ruths Steam Accumulators, Ltd., Glasgow, for the service at Grangemouth of Scottish Dyes, Ltd., is 44ft. in length and 14ft. in diameter, and is capable of storing 10,000 lb. of steam between the pressures of 100 lb. and 50 lb. per square inch.

ACCORDING to the *Kew Bulletin* a palm oil factory on the Gold Coast makes use of the waste fibre left after the extraction of the pericarp oil, and of the shells of the palm "nuts" after cracking and the removal of the kernels. A fuel briquette is made from these two waste products, and constitutes the sole fuel used on the small locomotives which haul the palm fruit from the outlying collecting areas to the central factory.

A PROCESS for mending cracked circular saws by welding, is described by Mr. C. Häusser in the *Welding Engineer*. He first bevels out the crack and drills a hole at the end. The saw is preheated to almost a red heat and nickel steel wire used in welding. The surplus metal is then ground off, but the saw is left badly buckled, so it is reheated and placed on a surface plate. Another plate weighing about 100 lb. is then dropped on the top. In a few minutes the saw can be removed, quite flat and generally of the right temper.

IN the course of a paper read before the West of Scotland Iron and Steel Institute, Mr. G. G. Beard described some experiments made to determine the drawing qualities of thin sheet metal. Tests, he said, had been carried out to determine the relationship between the depth of an impression and the applied pressure, the impression being formed by means of forcing the metal into a die under oil pressure. By using a standard pressure and a die of definite dimensions, the ductility factor was determined by means of the relationship found.

IT should be noted, says Mr. H. F. L. Orcutt, that the future of gear grinding will not be confined to hardened gears. Wherever extreme refinements in tooth contact are called for, the ground gear will supersede the cut gear, without regard to the material used, be it brass, fibre, cast iron or soft steel. There is now a demand for unhardened straight toothed spur gears with an accuracy which is practically impossible to produce uniformly in the cut gear. It is believed that gears finished on the gear tooth grinding machine meet this demand.

SANDS which have become saturated with a heavy asphaltic oil or a semi-liquid bitumen are known to underlie an area in excess of 2000 square miles in northern Alberta, in the vicinity of Fort McMurray on the Athabaska River. These deposits are usually named the Bituminous Sands of Northern Alberta. This area has been surveyed in great detail by Mr. S. C. Ells, of the Mines Branch, during the past ten years, numerous samples of these saturated sands have been subjected to analysis, and much experimental work has been undertaken to discover commercial uses for the materials present in these beds. An extensive report on the subject has just been issued in Ottawa.

IT will be remembered, said Mr. H. M. Cox, in a lecture given before the Coventry Engineering Society, that Robert Stevenson, when building the Menai Tubular Bridge, first constructed a model of the bridge one-sixth full size, and tested it to destruction. The model, which was 4½ft. deep and set to a span of 75ft., was broken altogether six times. After each test the model was repaired and strengthened, so that while at first it only carried a gross load of 35 tons before failure, it actually carried 86 tons at the conclusion of the series of tests. It will be seen from this that by judicious testing experiments, with either the full-sized members of a bridge, or, if these are too large, with small scale models of them, a great economy in material can be effected and the designer will have a fuller confidence in the safety of the structure after it is completed.

THE use of cast iron for filler in autogenous welding is, according to the *Canadian Blacksmith*, becoming less each year. It is not pickled as are the steel rods, so is not subject to the effect of hydrogen. Moulding sand left on the surface has a bad effect on the weld. In the matter of alloy filler rods, a nickel content of about 3½ per cent. adds somewhat to the hardness and much to the toughness of the weld metal. Manganese over 12 per cent. has been successfully used to add both toughness and hardness. Heat treatment is required on manganese steel welds so that the self-hardening chromium alloys are becoming more popular. Welds made with them have toughness and resistance to abrasion. Special low carbon rods are recommended by the makers for different purposes, such as sheet work, or for mild steel so as to give ductile and easily machined welds. Special rods are also fabricated for building up work, and there is a wide range of analysis produced.

IN an article on the recent Florida hurricane the *Engineering News-Record* says that intermittent or pulsating wind force is suggested by the behaviour of tall smoke-stacks and radio towers as compared with that of more rigid structures such as buildings or elevated tanks. The flexible structures failed, the more rigid structures resisted unharmed, though unquestionably designed for substantially identical wind-pressures. Under mere static pressure they should have shown equal resistance. But under pulsating forces the more flexible structures could sway and whip about in the storm gusts, and so undergo stresses out of proportion to the dead pressure. Rigid structures are proof against such action. In view of these facts, it seems to be necessary to deal with wind pressure rather differently than has been done in the past. Its dynamic character claims attention, with the possibility that its intermittent gusts may set up large oscillations in flexible structures.

Miscellanea.

THERE is some talk of building a new road and railway bridge at Freemantle, West Australia, at a cost of £1,000,000.

A NEW dynamite factory is being put up at Birmingham, Alabama, by the du Pont Company. It is to be finished by April 1st, 1927.

IT is proposed to construct a single-storey shed, 525ft. long by 100ft. wide, on the west side of the Gladstone Dock, north of Seaforth battery, on the Mersey. The shed will be equipped with cranes, railway lines, &c.

THE Management Committee of the Birmingham section of the British Industries Fair reported that on November 9th 25,000 square feet of floor space had been applied for, and allotted, in excess of the total space occupied by the 1926 Fair.

THE gentry of Tungshan, an island near Amoy, China, propose to establish a modern rice mill with an electric power plant which will also supply current for city lighting. One hundred thousand dollars is being raised to buy a plant from Shanghai.

AN experimental plantation of Chinese wood-oil trees is probably to be made in Tasmania. It is said that an area of 1000 acres, planted with seventy trees to the acre, will yield 250 tons of oil, which has a present price of £60 a ton in London.

ARRANGEMENTS are being completed for the erection of a sugar beet factory near Selby. The buildings will occupy about seventy acres on the East Riding side of the river Ouse, and will cost about half a million pounds. Two thousand acres of land have been secured from farmers for beet-growing.

A NEW bridge is to be built across the Yare at Yarmouth, by Sir Wm. Arrol and Co. It is to cost £200,000. The existing bridge is seventy years old and is not large or strong enough for modern requirements. During the reconstruction a temporary bridge is to be erected upstream of the new work.

WORK has started on an extension to the Riverbend Mill, Quebec, of Price Brothers and Co. to house two newsprint machines with a capacity of 100 tons a day each, and will be completed by January 1st, 1927. The company will then have a total newsprint output of 900 tons a day—500 from the Kenogami plant and 400 from Riverbend, together with 50 tons daily of paper board from Jonquière.

THE world production of artificial silk for 1926 is estimated at 333,000,000 lb., as against 193,000,000 lb. in 1925. The American production is given as about 80,000,000 lb. (50,000,000 lb. in 1925). Germany comes second with 66,000,000 lb. (26,000,000 lb.), then comes England with 45,000,000 lb. (28,000,000 lb.), and Italy holds the fourth place with 44,000,000 lb. (24,000,000 lb.).

A PLANT for the treatment of effluent liquor is, according to the *Chemical Trade Journal*, now being installed at the Foleshill works of the Coventry Corporation Gas Department. It will consist of four bacteria beds, each 120ft. diameter by 5ft. 6in. deep, with the necessary revolving sprinklers, pumps, tanks, &c. The Gas Committee has granted permission for a series of tests on the plant to be made under the auspices of the Effluent Research Committee appointed by the Institution of Gas Engineers.

AT the ordinary meeting of the Institution of Electrical Engineers, to be held on Thursday, December 2nd, a portrait of Michael Faraday, by Mr. George Harcourt, R.A. and the same artist's reproduction of the portrait of Lord Kelvin, painted by Herkomer for the Institution of Civil Engineers, will be shown in the Lecture Theatre of the Institution in the positions allotted to them. After introductory remarks by the President, Mr. Harcourt's portrait of Faraday will be presented to the Institution by Mr. Sydney Evershed.

RAPID progress is reported with the preparatory work in hand at Wheal Kitty Tin Mine, St. Agnes, and 150 men are now being found employment underground or on the surface. A Californian mill of twenty heads is in position, and the requisite dressing appliances are being got ready. The reservoir from which the water used for dressing purposes has hitherto been drawn has been replaced by another of half a million gallons capacity. As the work on the surface decreases the men liberated are being employed underground, where ore is being broken for the mill.

THE largest of the dredgers owned by the Bristol Port Authority is being overhauled locally by G. K. Stothert and Co. The vessel had been in commission for forty years, having been launched in 1886, and has done much useful work. Her three boilers and the seating and framework underneath will be renewed, while reconstruction work on her hopper and the renewal of all the hopper doors are also included in the contract. Her dredging ladder will be lengthened 7ft., which will increase the depth at which she is able to dredge from 36ft. to 42ft. This will make her far more effective in dealing with the solid material at the dock entrances. The work is to be completed in four months.

AT a recent meeting of the Cornish Institute of Engineers there was moved a resolution that the Institute should approach the Cornwall Chamber of Mines, and Captain A. H. Moreing, the member of Parliament for the mining division, with a view to obtaining a subsidy of £50,000 from the Trade Facilities Board for an intensive diamond drilling campaign for the purpose of opening up the mineral wealth of the county. The introducer of the resolution contended that, as the Government had subsidised the coal industry to such a great extent, there should be no difficulty in getting £50,000 for Cornwall, and pointed out that it was very costly to sink shafts, and it was not always possible to obtain the necessary money from the financial houses. A scheme of intensive diamond drilling would, he urged, benefit Cornwall more than anything else, and he pointed out that, while the world stocks of tin were low, the Federated Malay States, producers of 35 per cent. of the world's output, were 700 tons down in output in the first ten months of this year as compared with the same period of last year. The resolution was adopted.

THE TEMPLEBOROUGH FILE MANUFACTURING WORKS OF SHEFFIELD STEEL PRODUCTS, LTD.

(*For description see page 578*)

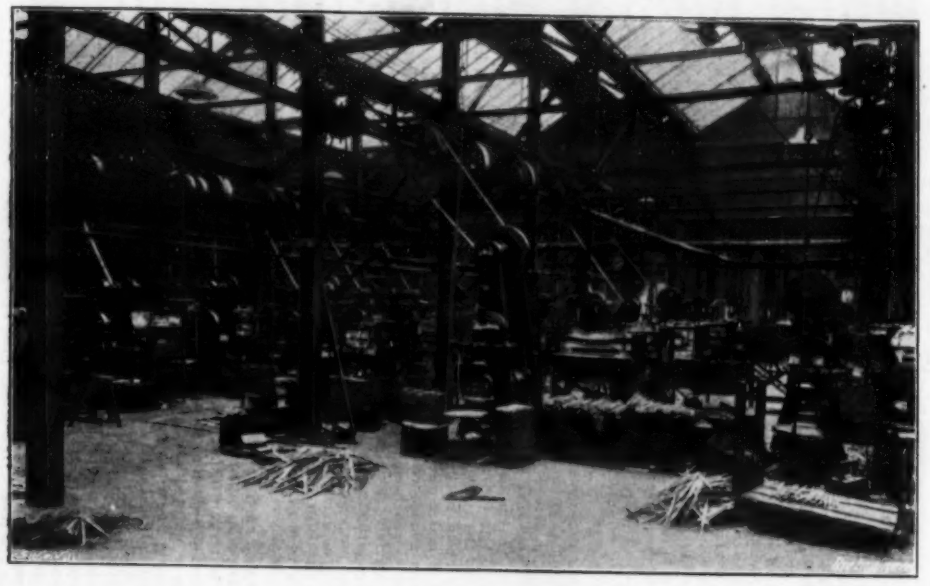


FIG. 6—GENERAL VIEW OF FORGE

FIG. 7—FORGING—GENERAL VIEW OF ROLLS

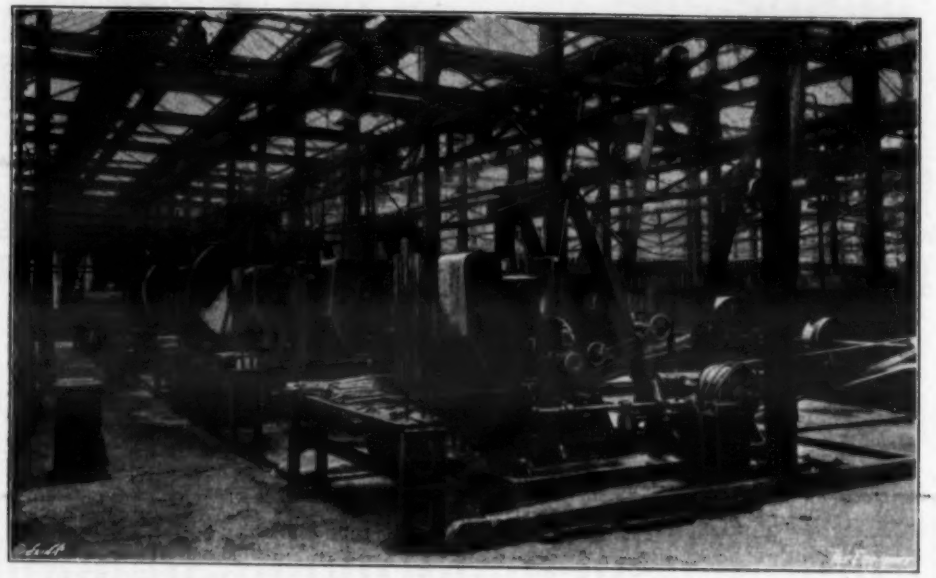


FIG. 8—GENERAL VIEW OF GRINDING MACHINES

FIG. 9—GENERAL VIEW OF FILE-CUTTING SHOP

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The Metallurgist

THE NOVEMBER NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

NOVEMBER 26, 1926.

The Commercial Limit of Steam Pressures.

At a time like the present when so much interest is being taken in the use of steam at very high pressures, the paper on "The Economic Value of Increased Steam Pressure," read by Mr. H. L. Guy before the North-Western Branch of the Institution of Mechanical Engineers, and reprinted in our last two issues, is decidedly opportune. Of Mr. Guy's competence to deal with his subject there can be no question, and whether or not one agrees with his conclusions as to the results to be obtained by the use of higher pressures, his presentation of his case was a model of what such a paper should be. Starting with perfectly acceptable data and reasoning from the properties of steam and from his own knowledge of the cost and efficiency of machinery, he arrives at the conclusion, broadly speaking, that it does not pay to use steam pressures greater than about 350 lb. per square inch under ordinary conditions of load factor and fuel cost. Such an opinion is surprising, to say the least of it. A pressure of 350 lb. per square inch is regarded to-day as quite an ordinary one. As long ago as 1917 the North Tees station of the Newcastle Electric Supply Company was designed to work with a boiler pressure of 475 lb. per square inch, and since that date several large stations have been constructed in the United States to work at 500 lb. and over. Among these may be mentioned the Philo station of the Ohio Power Company, the Crawford-avenue station of the Commonwealth Edison Company, and the Miami Fort station of the Columbia Power Company—all very large and important plants, with boiler pressures of 600 lb. per square inch. The same tendency towards higher pressures is to be noted on the Continent. A very big 620 lb. boiler is on the point of going into service in the Amsterdam station, and three boilers with a working pressure of 800 lb. per square inch have been in operation at Langerbrugge—see The Engineer, June 4th, 1926—for nearly a year. Furthermore, there is considerable activity on the part of continental manufacturers in the construction of boilers for pressures as high as 1500 lb. per square inch, and several such boilers are either at work or are emerging from the experimental stage. In the face of facts such as these, Mr. Guy's contention needs very strong evidence to make it acceptable. The curve he gives in his paper showing the average steam pressure adopted in British power stations for the last seventeen years indicates a continuous and marked tendency towards higher pressures. He, and those who think with him, might certainly point to the fact that the same designers who adopted 475 lb. at North Tees in 1917 dropped back to 375 lb. for the very important Barking station in 1924. But this one regression, if such it may be called, is a small thing to set against the general trend of events. Any engineer to-day who put down a capital station with a steam pressure of less than 375 lb. at the boilers, or, say, 350 lb. at the stop valves, would certainly meet with more criticism than one who adopted a boiler pressure of 475 lb., notwithstanding Mr. Guy's calculations. The consensus of expert opinion is that the next few years will see a considerable development in the direction of higher pressures, and there are many people who expect to see 600 lb. per square inch as fully standardised for power station work as 180 lb. or 200 lb. was a few years ago. As Mr. Guy's table of commercially economical pressures ranges from 227 lb. per square inch to a maximum of only 355 lb. for a station with a load factor of 50 per cent., it will be seen how wide is the gulf between the views of Mr. Guy and those of some modern power station engineers. Indeed, the highest pressure recommended in the paper for any conditions is only 460 lb. per square inch, and this for a station with low capital charges, and the unattainably good load factor of 100 per cent.

Mr. Guy has stated his case so fully that he may fairly turn to those who do not admit his conclusions and ask where he has gone wrong in his assumptions or calculations. That his figures will call forth a volume of criticism is certain, for his paper is a direct challenge to the trend of modern practice. It needed courage to make such a challenge. The paper is not a plea on the part of a timorous man for the safety of a beaten track. It is rather the reasoned contention of a responsible engineer that further advance can only lead to a profitless, though no doubt interesting, wilderness. It would, however, be the more convincing if there were no contented pioneers well ahead of the point at which Mr. Guy would call a halt. Crawford-avenue, with its 160,000 kilowatts of installed plant and its projected capacity of 750,000 kilowatts, is one of the several instances where some of the most experienced engineers in the world have decided to risk an enormous capital on their belief that a steam pressure far higher than Mr. Guy would admit would give them the best financial returns. Plants such as these cannot be called experiments, and one hears of no wish on the part of their owners to revert to lower pressures. The tendency is indeed all the other way. This is, in fact, the strongest reason for thinking that Mr. Guy's conclusions are wrong. Cumulative evidence is very powerful, although the individual items may not be convincing. Progress, moreover, involves change, and advances are not made by resting content with the pressures of to-day, or as we might even say reverting to those of yesterday. James Watt, with all his engineering insight, believed that steam pressures should be limited to a few pounds per square inch. We have improved upon that, and there is not the least reason to believe that we have yet gone as far as we can economically go. If Mr. Guy's paper leads, as we trust it will, to a fuller examination of the advantages as well as the disadvantages of higher steam pressures, it will do good. If, on the other hand, it is used as a ready-made argument by those who worship "the god of things as they are" it will be a misfortune. There are already enough obstacles in the way of progress without strengthening the hands of those who would discourage it. With so many of our power stations under municipal management, engineers need great courage and strength of character to take the risks of departure from well-tried practice, for they have little or nothing to gain by success, and everything to lose by failure. Nor do power station engineers, in general, get much encouragement to try new departures from the great manufacturing firms. Too many of the latter prefer to supply their standard products, and they discourage change by associating paternal warnings with unattractive quotations. No wise engineer will disregard the advice of an experienced manufacturer, though it may not always be wisdom to follow it. The temptation to a firm to supply standard and well-tried machinery, and to leave the risks to others is an intelligible one. But this policy carried too far is an endeavour to live on a harvest sown by the last generation, without themselves sowing for the future. In spite of Mr. Guy's argument that steam

pressures such as those at Manchester and Barking are about as high as can be economically used, it is disquieting to think that Great Britain is falling behind the United States and the Continent of Europe in the development of boilers and machinery for higher pressures. We do not want to see, when the market for such plant is more fully established, our own manufacturers running to their more experienced continental rivals for licences, throwing away at the same time the engineering prestige of this country, and incidentally much profitable business. This kind of thing has happened with regard to the marine oil engine, and it would be calamitous for it to be repeated in the case of other developments at present taking place. The real kind of "research" which will reinvigorate our industry does not consist in laboratory experiments half so much as in making new sorts of things and putting them to work.

A final thought in connection with Mr. Guy's paper may be addressed to those who may think it is the last word on the subject. The whole history of engineering and mechanical development is punctuated by pronouncements as to natural or economic limitations, and as often as these are made they are falsified by events. So well known and able a man as the late Sylvanus Thompson stated in his younger days that the incandescent electric lamp could never compete against the arc lamp on account of the enormously greater efficiency of the latter. It is reported, perhaps with less than complete justice, that the equally famous Dr. Lardner prophesied that no steamboat could ever cross the Atlantic, as it could not carry enough fuel for the passage. One has not to be very old to remember the contention that the safety bicycle could never supplant the old "ordinary," and even younger men will recollect solemn debates as to whether a motor car would ever be as serviceable as a horse and trap. The steam turbine had countless detractors who prophesied that it could never replace the reciprocating engine—one of the most amusing reasons being that as the latter only took steam during part of its stroke, whereas the turbine took it all the time, the turbine could never hope to compete on grounds of economy. Somewhat the same controversy ranged around voltages and vacua as exists at present with regard to steam pressures. People sought to predict the economic limits and usually put them considerably below those which are now current practice. When 28in. was a very high vacuum, it was sought to prove that 27·5in. should not be exceeded, yet to-day everyone who has adequate cooling water wants 29in. or over in a land station. These considerations tend to weaken one's faith in prophecies, even when supported by calculations, and we look to see before very long steam pressures in common use which are very considerably greater than Mr. Guy would seem to think justified.

Electricity in Agriculture.

At meetings of the Institution of Electrical Engineers the electrification of rural districts has often formed the subject of discussion, but, on the whole, the speakers have not been particularly enthusiastic. A further contribution to the subject was made last week by Dr. Ekström, who delivered a lecture dealing with the rural electrification in Sweden, where apparently the electrification of farms has for the most part proved a success. In south and central Sweden the Royal Board of Waterfalls and the South Swedish Power Company have developed extensive electrification schemes within their districts. From an economic point of view, however, electrification is not always justified, for it requires a certain density of population as well as a fair standard of prosperity, and a popular appreciation of the advantages of electricity in daily life. The determining factor for success is the consumption of electricity per head per acre of arable land within a reasonable measure of time. The Royal Board has divided Central Sweden into about 400 small local distribution districts, each with an average area of about 20 square miles, and it runs lines to a central point in each district, where it erects a transformer sub-station and sells energy at wholesale rates. To a local organisation, consisting of the leading men of the district, the Board hands over the sole right to build the local network, supply transformers and manage the retail supply of the district. Generally, the consumers in the district form themselves into a co-operative society, which provides the necessary capital for erecting the local network, charging to each shareholder interest and amortisation, costs of management and upkeep, as well as of the electrical energy consumed. The Royal Board reserves the right, however, to sell energy from its territory transformer stations independently of the local co-operative body, to all the larger power consumers residing within the local district.

In the year 1923 the Council of the Institution of Electrical Engineers appointed a committee for the purpose of reporting on the use of electricity in agriculture in this country, and one of the main conclusions arrived at was that although the actual consumption per acre or per farm appears small, yet the total acreage of farm lands in this country is large, being nearly 27 million acres, out of a total area of 56,788,366 acres in England, Scotland and Wales. The supply of electricity to farms, if carried out, would aggregate a very large total, say, under English conditions, 260 million units per annum, without ploughing or cultivation, and from two to three times that amount if electric ploughing and cultivation were adopted. The laying out of the work, the construction of the generating plant and cables, and the supply of plant and accessories would form a very important addition to the activities of the electrical industry, but this desirable state of affairs is not likely to be brought about easily. To what extent the Electricity Supply Bill will help rural electrification is a matter of conjecture, for an inspection of the map will show that transmission lines between the principal industrial areas will not affect many large agricultural districts. In many cases the supply of electricity to agricultural parts abroad has been brought about automatically by the necessity of having to erect long transmission lines for the purpose of conveying current from water power stations to places many miles away, but in this country, where water power is scarce, the need for long distance transmission lines has not arisen. Possibly, however, one of the main reasons why the electrification of continental rural districts has proved successful is that every effort has been made to simplify and cheapen distribution. In the Institution of Electrical Engineers' report to which we have alluded, it is shown that the cost of British rural distribution systems, designed to conform with the Electricity Commissioners' regulations, is considerably in excess of that of the lines erected in agricultural districts in other countries, and until that state of affairs is altered progress in the desired direction is not likely to be rapid. Cheap distribution is unquestionably the keynote to successful rural electrification. Regulations governing the erection of overhead lines in this country have long been a drawback to progress, and modification of these regulations so far as farms, villages and small industries are concerned, seem to be desirable. On the Continent the supply engineer is allowed to take his mains to the farmer with less hindrance than he is here. Moreover, the continental farmer has apparently been better educated as regards the merits of electricity. To induce the British farmer to use electricity, electrical engineers must provide cheap current and employ vigorous propaganda.

In farm buildings electric lighting is extremely desirable, and electricity is also eminently suitable for driving small machines, such as root cutters, chaff cutters, &c., but a small engine will do the job quite as well, and it is just as portable. There are, of course, many other uses to which electricity can be put on the farm, and provided the long-promised cheap supplies are forthcoming, there is no doubt that in due course the British agriculturist will adopt it; but, in our opinion, for many purposes the small internal combustion engine will continue to hold its own. A disadvantage of the electric motor, from the point of view of the farmer, is that it requires cables, which are a source of nuisance in connection with certain operations. There are a few electrical engineers who appear to believe that only by using electricity can the British farmer hope to survive, but there are others who recognise that for some purposes the internal combustion engine will not be easy to displace, and that the electrification of farms is not always remunerative to the supply undertaking.

Power from Warm Water.

Every schoolboy knows that warm water may be made to boil by merely reducing the pressure on its surface. This elementary fact was made the basis of an apparently serious proposition for obtaining power from sea water, presented to the French Academie des Sciences on Monday of last week, November 15th. The authors of the scheme are Monsieur Georges Claude, whose name is known in connection with the preparation of liquid oxygen, dissolved acetylene, &c., and Professor Paul Boucherot, a past-president of the Société des Electriciens. Had the proposal been launched under less dignified patronage we should probably not have thought it worth while to discuss it, but as it has received great prominence in the Paris Press it may be interesting to explain in what it consists. The principle will be easily understood from a brief description of the apparatus used to demonstrate it. The wheel of an ordinary Laval turbine, 15 cm. diameter, was mounted with its spindle vertical inside a glass flask and arranged to drive a tiny dynamo. The bottom of the flask contained lumps of ice, and air could be exhausted from it by a vacuum pump connected to the upper portion. Another flask, containing 25 litres of water at a temperature of 28 deg. Cent., was provided with an outlet in the form of a pipe which entered the first flask and terminated in a nozzle just above the blading of the turbine wheel. When the system was exhausted of air the water in the second flask boiled, its vapour passing away through the pipe and driving the turbine wheel. After leaving the wheel the vapour was condensed by the ice in the bottom of the flask. It is said that the turbine wheel was driven by this means at a speed of 5000 revolutions per minute, and enough power was obtained from the dynamo to light three little electric lamps for eight to ten minutes, after which the water had been cooled to 20 deg. Cent. or so by its evaporation and apparently refused to boil any longer.

That an experiment of this nature could be successfully carried out there is no reason to doubt, but that it has any practical bearing whatever on the generation of power is more than difficult to believe. The enthusiasm of its authors is apparently boundless. Their argument, freely translated from the communication we have referred to, is as follows:—The surface of the sea, in the tropics, has an average temperature of from 26 deg. Cent. to 30 deg. Cent., according to the locality, and the variation of temperature in any one place does not exceed 3 deg. Cent. from one year's end to another. On the other hand, at great depths extremely cold water can be found, even in tropical seas, the temperature at a depth of 1000 m. being only 4 deg. or 5 deg. Cent. If, then, the surface water be put into a sort of boiler and the atmospheric pressure be removed it will boil and produce a low-pressure steam, which can be used to drive a turbine, before being condensed by the cold water from the depths. The water will remain in the boiler just long enough to cool a certain amount by evaporation and then will be expelled and replaced by fresh warm surface water. The authors estimate that turbines can be constructed to work with this low-pressure steam with an efficiency of 75 per cent. at least, and that 45,000 kilogramme-metres (325,485 foot-pounds) of work can be produced from each cubic metre (2270 lb.) of sea water. With a plant dealing with 1000 cubic metres of warm water per second an output of 400,000 kilowatts might be reached, at a capital cost not greater than that of the most favourably situated hydro-electric plants. Besides the benefits of cheap power, the authors envisage additional advantages to the tropics from the "torrents of cold water" which are to result from the operation of the system.

It may be interesting to look into the arithmetic of this wonderful proposal. Taking the most favourable of the authors' figures for the respective sea water temperatures, but using Fahrenheit units for convenience, we will assume the surface water to be at 87 deg. Fah. and an unlimited supply of cold water from the depths to be available at a temperature of 39 deg. Fah. We will further assume the useful heat of the warm water to be exhausted when it falls to a temperature of 78 deg. Fah. by evaporation, as in the case of the experimental model. Each pound of warm water, therefore, before being rejected, would part with 8·97 B.Th.U. and it would require over 116 lb. of water to pass through the boiler to supply enough heat to produce 1 lb. of steam by evaporation. The steam produced would have an average pressure of about 0·55 lb. per square inch absolute, so that the "boiler" would be working under the conditions of a condenser with something like a 28·9in. vacuum. The actual condenser, supplied with cooling water at 39 deg. Fah. could not possibly have a vacuum exceeding 29·96in., corresponding to an absolute pressure of 0·117 lb. per square inch. Working between these pressures, an ideal turbine working on the Rankine cycle would have a theoretical steam consumption of practically 40 lb. per kilowatt-hour. Assuming, as the authors do, that a machine could be built with an efficiency of 75 per cent. for such conditions, we arrive at a figure of 53 lb. per kilowatt-hour. What kind of thing the turbine would be we can leave to the imagination. As the steam with which it works would have a volume of about 580 cubic feet per pound, it would require a steam pipe over 23ft. diameter to supply a 10,000-kilowatt turbine, assuming as high a steam velocity as 200ft. per second to be employed. Boilers, condensers and turbines would all be proportionally enormous, and the impossibility of maintaining vacua of 29in. or more in such a system are sufficient to demonstrate the utter futility of the proposal. If Messrs. Claude and Boucherot can really find a practical way of producing energy from water at 87 deg. Fah. by the use of water a few degrees

colder, there is ample scope for them to utilise the discharged circulating water from some of the power houses in Europe before developing the tropical seas.

Obituary.

HARRY FRANCIS.

THE death occurred on Sunday, the 21st inst., at his home in Plymouth, of Mr. Harry Francis.

Mr. Francis, who was seventy-five years of age, was educated at Exmouth House School, Devonport, and when only eighteen succeeded his father as engineer to the Devonport Water Company, a position which he retained until the Corporation took over the undertaking. In 1903 he became a consulting engineer, and in that connection was associated with most of the water schemes, not only in the Plymouth district, but throughout Devon and Cornwall. He directed the building of the reservoir at Ivybridge, and was one of the engineers who advocated the raising of the dam at the Burrator Reservoir of the Plymouth Corporation Water Works, a work which was postponed by the war but which is now in process of being completed.

Mr. Francis was one of the expert witnesses who gave evidence on behalf of the Devonport Corporation when an inquiry took place which resulted in the amalgamation of that town with Plymouth.

Literature.

Unemployment; The Gateway to a New Life. By GEORGE W. MULLINS. London: Longmans, Green and Co., Ltd. 1926. Price 6s. 6d.

THE author of this book will be known to many of our readers through his association with the metal industries of Birmingham. He writes, not as so many economists do, with little more than an academic acquaintance with their subject, but from inner knowledge of the ramifications of business and industry. For this reason his analysis of the causes of unemployment that have been propounded by various schools of thought, to which he devotes the first portion of his essay, may be read with more than ordinary interest. He is dissatisfied with all the "causes" which he enumerates. We do not suggest that he sees in none of them reasons why unemployment is becoming a chronic complaint in the industrial world, but rather that, in his view, there are none of them that are inevitable, that could not be removed by the more intelligent organisation of communities.

It is, however, with his remedy that we find ourselves chiefly concerned. He takes us back, if not indeed as far as the Garden of Eden, at least to those far-off days when agriculture was a part of the existence of every man, whatever his other craft might be. It is in the passing of that co-ordination of agriculture and industry that he sees the root cause of unemployment, and in the resuscitation of it that he visualises the removal of that persistent malady. "I know," he writes, "that a conception of unemployment as due to something so vague, so general, as the world lack of co-ordination between agriculture and industry will seem to industrialists a painful and unhelpful conclusion. I cannot agree that it need be either. I believe it can lead us to fruitful remedies—remedies impossible so long as our thoughts move among unreal or secondary causes." And, again, "We have to recognise that modern civilisation, which has increased so much the size of our towns and has so completely divorced town and country, has added to the evil (food prices). The point at which we have to attack, if we are to bring agriculture, food production, and industry into a more vital contact is, I believe, precisely this divorce. We have to spread industries out upon the land, and make the industrial worker a sort of land worker. No mere 'back to the land' policy is going to save us. Men will not return from our towns—where is companionship and gaiety and many chances and adventures, if also grave risks—for the loneliness and long hours, the poor housing and depressed outlook of the old country life."

Mr. Mullins' scheme is to get industrialists back to the land, but under new conditions. He describes a factory set down in some country area but with all proper facilities for transport, and surrounded by an industrial village of which every house has a sufficient area of land to provide it with all the vegetable products needed by the household. The industrialist after his labour—five days a week—is to cultivate the land, thus finding a useful and healthy occupation for his leisure. The worker is to economise so much by the cultivation of his own acre that he will be content to accept lower wages for a shorter week.

That is, in merest outline, the scheme the author puts before us. Examples of such communities already exist, and we have little doubt that, here and there, the plan may succeed. But the snag upon which Mr. Mullins' plan will founder as a general cure is the widespread dislike of men for agricultural pursuits. In such a community it would be impossible to tolerate a single workman who was not prepared to cultivate his plot. He would upset the scheme and introduce disaffection. By careful selection an agri-industrial community might be maintained in favourable circumstances, but we fear that of the fifteen millions or so who make up the "working" population of Great Britain, there is such a small proportion ready to throw itself into a semi-agricultural life, that as a serious solution of the unemployment problem the scheme would scarcely be fruitful.

SHORT NOTICE.

The Islanders. By Archibald Hurd. London: Cassell and Co., Ltd. Price 3s. 6d.—The islanders of this little volume of articles collected from our contemporary, "Blue Peter," and revised and extended are, of course, the people of Great Britain. Mr. Hurd has a flowing and easy pen, and he chats in an agreeable way about the various aspects of shipping, and always with a sturdy belief in the race to which he belongs. He handles statistics with ease, introducing them as it were casually, but by their aid bringing out some point which he desires to make. He is never for one instant gloomy. Even when he has to show that the special amenities prescribed by the Board of Trade for British seamen put a serious tax upon British shipping and render competition with nations that are content with far rougher conditions of sea life difficult, he stoutly refuses to see anything but a rosy future for British shipping. This attitude is all to the good. Chronic despondency is far more likely to rob us of energy than over-confidence is likely to make us supine. British shipping, which before the war carried 40 per cent. of the world's trade, may have no little difficulty in recovering that supremacy, but we are disposed to agree with Mr. Hurd in his optimism, and to hold that in the not too distant future the British flag will stand once again unrivalled. We cordially commend this little volume to all those who desire to know something of the vast shipping business of Great Britain. We can assure them that they will never find it tedious, and that Mr. Hurd has a story to tell and tells it well.

General Strikes and Road Transport. By George Glasgow. London: Geoffrey Bles. 1926. Price 5s.—One of the most surprising facts connected with the great strike of last May was the efficiency with which the essential transport services were conducted, despite the almost complete paralysis of the railways. In this little volume Mr. George Glasgow tells us how it was done. The history of the wonderful organisation which was ready at a moment's notice to undertake the duty of providing the country with food in the event of the stoppage of the ordinary means of transport goes back to Mr. Lloyd George's Government of 1919, when some step had to be taken to prevent the railway strike of that year starving the people. In the scheme established to meet that emergency by the Coalition Government the large number of war lorries and lorry drivers that were still available cannot be overlooked. In the recent crisis the Government had not at its hands any such easy means of dealing with the problem, but in essence it carried on the 1919 scheme, with the principal difference that it depended for transport upon the voluntary offer of vehicles and did not commandeer any of them. We believe that hitherto no complete and connected account of the system has yet been published, and Mr. Glasgow's volume will be welcomed by all who desire to see how the efforts of those who sought to starve the country into submission were countered. It will also convince those who are too ready to believe ill of any Government, and to think that nothing is ever done until the last moment, of their error. The scheme which Mr. Glasgow describes is a standing organisation, which is ready for immediate action on the approach of an emergency.

Early British Railways: A Short History of their Origin and Development. By Henry Grote Lewin. London: The Locomotive Publishing Company, Ltd. Price 12s. 6d.—The period covered by this book is that which extends from 1801 to 1844. It includes, therefore, what we may call the pre-railway era in which plateways and horse traction were being developed, and it ends with the passage of Gladstone's Railway Bill, which caused such a fluttering some eighty-two years ago. The passage of that Act in a much attenuated condition coincided approximately with the opening of the great railway mania, and there is a suggestion at the end of the volume that Mr. Lewin proposes to deal with that dramatic chapter in railway history at some future time. In the present volume he has not only brought together in a convenient form the essential details connected with the railways belonging to the period covered, but has given in outline a good deal of incidental history. The volume will, therefore, be found especially useful for reference by those who are interested in the development of railways. The author is a railway man himself, and for many years has devoted himself to the statistical history of railways. In this volume he has done what he set out to do concisely and well. There is no padding and no verbiage, but he gives us as briefly as possible those historical facts which the railway economists should know.

The Theory and Practice of Radio-frequency Measurements. By E. B. Moullin. London: Charles Griffin and Co., Ltd. Price 25s. net.—Although a great deal has been written on radio-frequency measurements, we believe that we are correct in saying that this is the first book on the subject. It is well known that Mr. Moullin, who is the inventor of a thermionic voltmeter, has been actively associated with these measurements for some years, and there is probably no one who is more capable of writing a book of this description. His object has been to produce a manual which will be useful as a handbook on the laboratory table for use and reference whilst measurements are actually being made. To a large extent the book is based on the author's own practical experience, but extracts are given from the papers of many other writers who have given attention to the subject. As far as possible, the author has aimed at illustrating every measurement by an example from his own experience, and he has also given copious instructions concerning the manipulation of apparatus and warnings against small disasters. Whilst the book is not devoted entirely to the art of radio communication, it is, of course, inevitable that a great portion of the volume relates to that art. Though primarily a laboratory manual, the volume should also prove of value to advanced students at universities and technical colleges. There is no doubt that the author has met a need, and those engaged in high-frequency electrical work will find the volume distinctly useful.

BOOKS RECEIVED.

Centrifugal Pumps. By G. Higgins. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 9s. 6d. net.

British Rainfall, 1925. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 15s. net.

The Oil War. By Anton Mohr. London: Martin Hopkinson and Co., Ltd., 14, Henrietta-street, W.C. 2. Price 7s. 6d. net.

Polyphase Induction Motors. By R. D. Archibald. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 5s. net.

Rotary and Motor Converters. By E. F. Smith. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 7s. 6d. net.

The Motor Industry of Great Britain, 1926. London: The Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. Price 2s. net.

Home Fires Without Smoke. Edited by C. Elliott and Marion Fitzgerald. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 3s. 6d. net.

Annali dei Lavori Pubblici, già Giornale del Genio Civile (Ministero dei Lavori Pubblici, Consiglio Superiore). Anno LXIV. No. 9. Settembre, 1926. Rome: Stato Libreria.

Industrial Safety Organisation for Executive and Engineer By L. A. De Blois. London: The McGraw-Hill Publishing Company, Ltd., 6, Bouverie-street, E.C. 4. Price 20s. net.

The Scientific Principles of Petroleum Technology. By Dr. Leo Gurwitsch. Translated and revised by H. Moore. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 25s. net.

Statement and Engineering Report by the Hydro-electric Power Commission of Ontario, submitted to the International Joint Commission respecting the Proposal to Develop the St. Lawrence River, 1921. Toronto: Hydro-Electric Power Commission of Ontario, 190, University-avenue, Canada.

SIXTY YEARS AGO.

AN article entitled "The Central Fire of the Earth," which we published in our issue of November 23rd, 1866, must have been the cause of considerable alarm to readers to whom the science of geology was a new subject of study. It is not very clear what connection we saw between the subject of the article and the art of the engineer, but the article made interesting reading, and that perhaps in those less crowded days was no doubt sufficient reason for publishing it in the columns of a technical journal. Perhaps, however, we saw in the subject—as indeed some of our own time have done—an opportunity for a grandiose application of that control over the forces of nature which it was the engineer's boast that he could exercise by his arts. It was suggested that the earth might by the action of its internal fires one day follow the example of the "missing planet" between Mars and Jupiter, and burst into fragments. Possibly we anticipated that the engineer might be called upon to devise means for preventing the cataclysm. On the other hand, our object in publishing the article may have been to suggest the possibility that the earth's "central fire" might, while the globe was yet whole and habitable, be applied to the use and convenience of man, an idea which has since become almost common. Whatever may have been the precise object of the article, it was, as we have said, of an interesting kind. Largely it was occupied by giving particulars of earthquakes and volcanic eruptions, which within historic times had disturbed the earth's surface and frightened mankind. There were quotations from quaint old contemporary accounts of two "visitations" which befell in England in 1426 and 1580, and brief references to many other terrestrial disturbances in this country and abroad. Geologists had still in those days to secure acceptance of their view that the interior of the earth was a liquid mass at high temperature. We sought to confirm that view by expounding the theory, still popular in some quarters, that earthquakes were caused as a result of water from the surface reaching the fires below the crust through fissures and creating enormous pressure by the generation of steam. Volcanic action was also brought into the picture, and no doubt the recent eruption in the island of Santorino in the Grecian Archipelago would dispose our readers to accept the view that such action represented the liberation of the "pent up furnaces" beneath our feet. Additional evidence in the geologists' favour was found in the increasing temperature encountered in deep coal mines, and finally the history of the broken planet was recorded to close the discussion. Kepler had noticed the disproportionately large space between Mars and Jupiter, and soon afterwards Bode advanced his empirical law of the planetary distances and suggested that there was a planet missing between these two bodies. It was not, however, until 1801 that a planet, the little body known as Ceres, was discovered in the vacant position. During the succeeding fifty years other small planets, Pallas, Juno, Vesta, Astræa, Hebe, Iris and Flora, were discovered in the same neighbourhood, and it became recognised that they were the fragments of a large body that had burst by internal convulsion. Here and there in the article we encounter a certain amount of scientific crudity, but reading it sixty years after it was written, we are struck by the fact that in the interval our knowledge concerning the cause of earthquakes, the action of volcanoes, and the internal constitution of the earth, has advanced scarcely at all.

A 1,000,000 Cu. Ft. Electrically-Welded Gasholder.

In our issue of February 26th last we published a short article on an electrically welded gasholder which was then under construction at Melbourne. The holder has since been completed and put into service, and we are enabled to place before our readers the following additional particulars regarding it.

THE GASHOLDER UNDER CONSTRUCTION

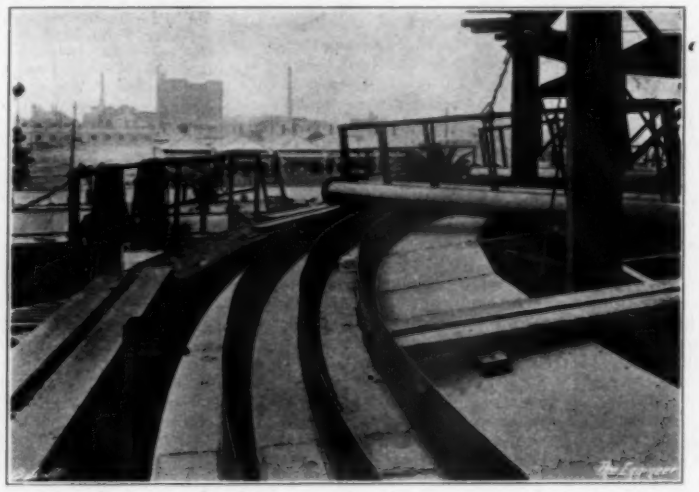
SETTING CIRCULAR PLATE IN BRICK TANK

The holder, which is known as the Fitzroy, or No. 2 holder, replaces a single lift holder which had been contained in a tank, 102ft. diameter and 21ft. 6in. deep. As it was decided that the new holder should have four lifts, each 32ft. 6in. deep, it was necessary that the tank should be extended in order to increase the depth to the required figure. The centre of the original tank had not been removed, its designer having left a dumpling, which had to be cut back to make room for the four lifts of the new holder. Furthermore, the holder was most awkwardly situated for erection and for extensions to the tank, as there was a public street within a few feet of the tank on two sides, and the streets varied in level from 3ft. to 5ft. below the original tank coping. For reasons of economy, speed and water-tightness, it was decided to make the tank extension by means of a ring of steel plates rising above the ground level, and to take the new part down to well below the level of the footpaths of the street.

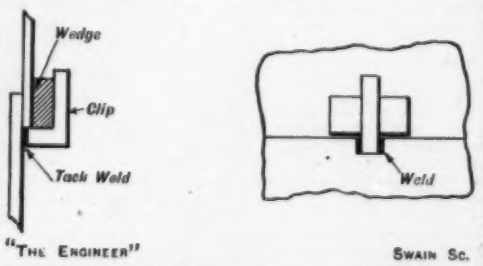
The extension was 17ft. 6in. overall in height, and its lower rim was taken down 6ft. into the old brick tank, so that the actual extra depth of tank obtained was 11ft. 6in. The ring is composed of four tiers of plates, the bottom tier being $\frac{3}{8}$in., the second tier $\frac{5}{16}$in., and the two upper tiers $\frac{1}{4}$in. thick. The forming of the ring was effected entirely by electric welding, which was carried out by the Metropolitan Gas Company's own employees and all preparatory work was done in the company's shops, "Quasi-arc" electrodes being employed. The only shop work done to the plates was to roll them to their proper curvature. No marking off, shearing, punching or drilling was done, as the foreman erector devised a simple and ingenious method of holding the plates together for assembly and welding. This device, which is shown in the accompanying drawing, consisted of a number of shaped clips cut out of old $\frac{1}{2}$in. or $\frac{3}{8}$in. scrap, and some hardwood wedges. On starting to construct the second tier of the ring, one of these clips was welded on to the bottom ring at the correct height, and the end of a plate to form the second tier lowered on to it. After bringing the end of this plate to its correct position a wedge was driven in, and then further clips were tack-welded on as required and the plate wedged up. Sufficient tack welds were then made on the plate landings to secure them. The wedges were then removed, and the clips were knocked off, to be used again for assembling other plates. After the first few plates had been put together and the erection gang had got used to this new idea, it was found to be easier and quicker than the conventional methods of bolting up the work, the time taken in welding being little more than that of caulking alone required in first-class riveted work for a heavy tank of this nature, so that the savings made over riveted work included the marking off, shearing, punching and riveting times.

The joint between the steel extension ring and the old brick tank was made by cutting a chase all round the brickwork of the tank at the proper level, and building in a curved plate for the steel extension to rest on. The first two tiers of plates of the new structure were welded up above the level of the brick tank coping, and were then lowered on to this circular joint plate. After the tank extension had been completed by the addition of the two upper tiers, the connecting tier was welded on to this plate, and the space, 2in. wide, between the original brickwork and the steel extension was afterwards filled in with rich cement concrete. This method gave a very satisfactory joint, and when the tank was filled with water, no sign of weeping was found from the joint or from any of the welded joints.

VIEW SHOWING NESTING OF LANDING STAGES AND GUIDE BRACKETS



VIEW SHOWING THE FOUR LIFTS AND PART OF SUPPORT FOR CROWN



METHOD OF HOLDING PLATES FOR WELDING

During the time the tank extension was being built the centre column of the umbrella framing for supporting the roof of the holder was placed in position and a temporary steel staging to carry a circular track to accommodate the revolving gantry crane was erected. An extension plate was attached to the top of the centre column to form a pivot for the revolving crane. This crane, which our readers may remember was itself an electrically welded structure, was then used to lift all the material for the four lifts of the gas bell, as well as the guide framing, into position.

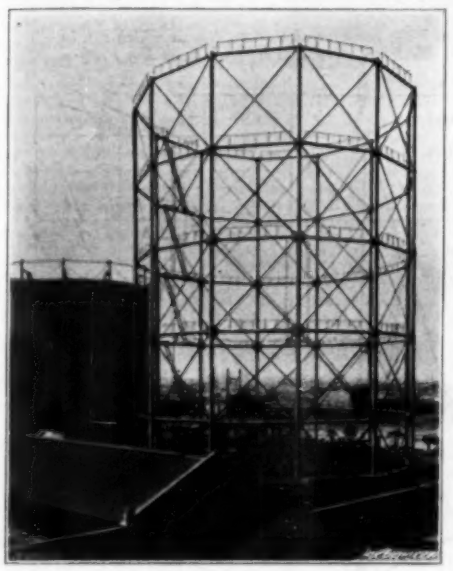
The assembly and welding of the umbrella framing for the crown, the four inner lifts with their vertical stays and guides and the tank balcony were proceeded with simultaneously. The four lifts of the floating bell are of similar design and were assembled and welded in the same manner. The respective sizes are:—Outer lift, 99ft. 7in. diameter by 32ft. 6in. deep; second lift, 93ft. 7in. diameter by 32ft. 6in. deep; third lift, 96ft. 7in. diameter by 32ft. 6in. deep; and inner lift, 90ft. 7in. diameter by 32ft. 6in. deep. Each lift took three weeks to erect and weld completely.

The engineers discarded chequered plates for all footways and platforms, preferring to form the latter by means of 2in. by $\frac{1}{4}$in. steel flats welded on to the supporting joists. There was found to be great economy in this, as, with flats, only a little over half a ton of metal was required as against $1\frac{1}{2}$ tons of chequered plate to cover the same area.

The guide framing, which is novel both in design and construction, consists of twelve standards, each 146ft. high, with five tiers of horizontal struts and diagonal bracing. These standards are tubular in form, and are made of $\frac{1}{4}$in. steel plate welded at the seams and butts, the diameter being 18in. inside for three lower bays and 15in. in the two upper bays. The horizontal struts are also tubular, and are made of $\frac{1}{4}$in. steel plate, those in the three lower bays being 15in. diameter and those in the two upper bays 12in. diameter. The tubes were made of 72in. wide plates lap welded at circumferential joints and butt welded longitudinally. All the laps were welded on the outside only, a full fillet weld being used. The right-angle connections between the standards and the horizontal struts, with their flanges and brackets, were formed integral with the standards and were all assembled and welded in a specially made jig so as to ensure uniformity and correct angles. The standards were erected in two lengths, the lower being 88ft. and the upper 58ft.

The completed weight of the structure is 441 tons, made up as follows:—Floating bell, 251 tons; guide framing, 135 tons; steel tank extension, balcony and stairways, 35 tons. The whole structure took seven months to complete, including all holidays, filling the tank with water and testing, with the maximum of twenty-eight men, including welders. The holder passed all its tests most successfully and no evidence of a leak in any of the welded joints was discovered. The shape is said to be excellent and the holder to have a very good appearance.

It is of interest, while on the subject of electric welding, to note that the superintendent of construction of the Metropolitan Gas Company of Melbourne, Mr. H. E. Grove, has, under the direction of Mr. J. N. Reeson, M. Inst. C.E., the engineer-in-chief of the company, helped to form what is believed to be one of the most complete welding organisations in the world. No rivets or bolts are used in any steel structural work other than for tacking purposes. During the last six years over 10,000 tons of structural steel work has been electrically welded, including five gasholders, the largest being 760 tons in weight, two of 500 tons, one of 441 tons—that just described—and one of 250 tons, besides two steel vertical retort houses, 86ft. high, each 500 tons in weight and carrying 1800 tons of brickwork, with 600 tons of coal in bunkers at the top of the buildings. One of these retort houses



THE FRAMEWORK COMPLETED

has been in operation for four years. To ensure good work piecework is not adopted, and, as far as possible, individual welders' initials are branded or painted on their work. It is of interest to note that the construction department of the company used nearly 120 miles of electrodes between September last year and July of this year, purely on its own constructional work.

We are indebted for the foregoing details and for the photographs from which the engravings accompanying this article were reproduced to Mr. E. J. Rigby, of Robert Bryce and Co. Pty., Ltd., of Melbourne; to Mr. H. E. Groves, superintendent of construction of the Metropolitan Gas Company, Melbourne; and also to the Quasi-Arc Company, Ltd., London.

Electric Locomotives:

A Method of Classifying, Analysing, and Comparing their Characteristics.*

By T. A. F. STONE, of the North-Western Railway, Lahore, India.

Introduction.—A vast amount of technical literature has been written about electric locomotives, their mechanical and electrical features, their performances in service, and their merits and demerits as compared with steam locomotives. This paper deals with an aspect of the subject which does not appear to have received attention, and that is a method by which electric locomotives as well as steam locomotives can be classified into types on a common basis, so that their characteristics can be analysed and compared with each other and their respective merits deduced therefrom.

There is much about electric locomotives that is puzzling to the steam locomotive engineer. There are no external evidences of the latent power of the machines, and no external signs to determine the sphere of utility—that is, their suitability for passenger, goods or shunting services. With steam locomotives, the size of the boiler, its working pressure, the number and diameter of the cylinders, the wheel arrangement, the number and diameter of the coupled wheels, the presence or absence of a tender, all of these external marks establish the identity of the steam locomotive and enable one to gauge its power and sphere of utility. On electric locomotives these external marks are either absent or without significance. For example, "wheel arrangements" are useless for identifying or classifying electric locomotives, since very often the same wheel arrangement may be common to a number of types. Thus the 0–4–4–0 wheel arrangement is common to passenger, freight and shunting electric locomotives and to electric motor coaches. Some other method of classification must be resorted to, and the author proposes for this purpose the method described later, which is believed to be original. He hopes to show how it is possible to deduce and compare the relative merits of various types of electric locomotives, merits so radical in character and numerous in their variety that steam railway engineers find it difficult to concede their validity.

Leading Characteristics of Steam and Electric Locomotives.—In order to classify the characteristics, it is necessary to choose those that are common to both types, and thence deduce a basis of comparison. The characteristics of steam locomotives include tractive efforts, heating surfaces, grate areas, cylinder volumes, adhesive weights, total weights in working order, weight of motive power equipment and horse-power.

The characteristics of electric locomotives include tractive efforts, adhesive weights, total weights in working order, weight of electric motive power equipment and horse-power.

For the purpose of this investigation, the following characteristics have been chosen common to both systems as being the most suitable:—

H P = The average horse-power which, for this paper, has been taken as equal to twenty times the grate area in square feet for the steam locomotives and equal to the one-hour horse-power rating for the electric locomotives.

A = The adhesive weight in tons of the locomotives when in working order.

E = The weight in tons of the motive power equipment which, for the steam locomotive, includes the weight of the boiler, water, coal, steam pipes, cylinders, pistons, piston-rods and motion, and for the electric locomotive includes the weights of the motors and the electrical equipment.

W = The weight in tons of the locomotives in working order.

The absolute values of the above characteristics are useless for comparing steam and electric locomotives, but their relative values or "ratios" between them give the required basis of comparison. For instance, the ratio $\frac{HP}{A}$ bears typical values for passenger engines, other typical values for goods engines and still other typical values for shunting engines. Further, these typical values are different in the case of steam locomotives from what they are in the case of electric locomotives, as will be shown later.

Classification of Characteristics.—In order to carry out his investigations, the author collected data regarding some ninety-two steam and electric locomotives, classified them and calculated the values of the characteristics HP, A, E, and W, as well as the values of the various ratios subsisting between them, which are $\frac{HP}{A}$, $\frac{HP}{E}$, $\frac{HP}{W}$, $\frac{E}{W}$, $\frac{E}{A}$ and $\frac{A}{W}$. An abstract of the results is tabulated in Table II., and a still further condensed abstract in Table I.:

TABLE I.—*Average Values of Ratios* $\frac{HP}{A}$, $\frac{HP}{W}$ *and* $\frac{A}{W}$ *for Steam and Electric Locomotives.*

Type of locomotive.	Steam locomotives. $\frac{HP}{A}$	Steam locomotives. $\frac{HP}{W}$	Steam locomotives. $\frac{A}{W}$	Electric locomotives (average of all systems) $\frac{HP}{A}$	Electric locomotives (average of all systems) $\frac{HP}{W}$	Electric locomotives (average of all systems) $\frac{A}{W}$
Passengers ..	15·4	5·67	0·375	30·89	22·99	0·753
Goods	10·96	5·70	0·528	19·18	18·24	0·940
Suburban motor coach	12·37	4·18	0·337	13·59	11·15	0·79
Shunting ..	9·03	6·31	0·701	11·15	10·32	1

Only three of the ratios have been shown in the above table in order to make the issues more clear. The complete abstract of average values for all the six ratios referred to is given in Table II.

It will be noted in Table I. that the three ratios chosen are higher in every case for the electric locomotives than for the steam locomotives of the same type.

Also the ratio $\frac{HP}{A}$ is highest for the higher-speed passenger locomotives—both steam and electric—and lowest for the lower-speed shunting locomotives—both steam and electric. In other words, the ratio $\frac{HP}{A}$ is a measure of the speed for which the locomotive is designed, a fact which can be reasoned out as follows:—

The horse-power of a locomotive is proportional to the product of its tractive effort and its speed, and the former is proportional to the adhesive weight of the locomotive. Consequently, the horse-power of the locomotive may be said to be proportional to the product of its adhesive weight and speed. Therefore, $\frac{HP}{A}$ is proportional to $\frac{A \times \text{speed}}{A}$, that is, proportional to the speed.

In the same way, it will be shown that the other five ratios, $\frac{HP}{E}$, $\frac{HP}{W}$, $\frac{E}{W}$, $\frac{E}{A}$, and $\frac{A}{W}$, bear typical values for steam passenger, goods and shunting locomotives, and other typical values for electric passenger, goods and shunting locomotives. To show this, Table II. has been prepared. From the study of this table, the following conclusions may be drawn:—

(1) That the horse-power per ton of adhesive weight is much higher for electric than for steam locomotives of the same type.

(2) That the horse-power per ton of electric equipment for the electric locomotives is much higher than the horse-power per ton of steam equipment for the steam locomotive.

(3) That the horse-power per ton of total weight in working order is much higher for electric than for steam locomotives of the same type.

(4) That the weight of the electric equipment is approximately the same as the weight of the steam equipment for locomotives of the same total weight.

(5) That for locomotives of the same adhesive weight, the weight of the electric equipment is much less than that of the steam equipment.

(6) That passenger electric locomotives have the greatest value of the ratios $\frac{HP}{A}$, $\frac{HP}{W}$ and $\frac{E}{A}$, and the least value of the ratio $\frac{A}{W}$, as compared with electric goods and shunting locomotives, whether direct-current, single-phase or three-phase.

(7) That shunting electric locomotives have the least value of the ratios $\frac{HP}{A}$, $\frac{HP}{W}$ and $\frac{HP}{E}$, and the greatest value of the ratio $\frac{A}{W}$ as compared with electric passenger and goods locomotives, whether direct-current, single-phase or three-phase

(8) Electric motor coaches have the least values of the ratios $\frac{E}{W}$ and $\frac{E}{A}$ of all the types considered, whether direct-current, single-phase or three-phase.

(9) Electric goods locomotives have ratios intermediate in value between those of passenger and shunting locomotives.

(10) That of the electric locomotive types, the ratios for the single-phase system most resemble that of the steam, and the ratios for the three-phase system least resemble those of steam locomotives. Thus the determination and classification of the above ratios for any steam or electric locomotives furnishes a method of identifying its type or sphere of utility.

TABLE II.—*Classification of Characteristics of Steam and Electric Locomotives (Being the Average Value of Ninety-two Steam and Electric Locomotives).*

Type of locomotive.	Average values of ratios. $\frac{HP}{A}$	$\frac{HP}{E}$	$\frac{HP}{W}$	$\frac{E}{W}$	$\frac{E}{A}$	$\frac{A}{W}$
Passenger—						
Steam ..	15·4	12·85	5·67	0·443	1·201	0·375
S.P.S. ..	23·7	32·9	16·26	0·499	0·703	0·688
D.C.S. ..	24·78	46·5	18·8	0·404	0·521	0·78
T.P.S. ..	44·2	—	33·9	—	—	0·79
Goods—						
Steam ..	10·96	12·00	5·7	0·476	0·914	0·528
S.P.S. ..	14·34	27·06	12·03	0·450	0·546	0·85
D.C.S. ..	15·4	41·9	14·9	0·358	0·374	0·97
T.P.S. ..	27·8	—	27·8	—	—	1·00
Shunting—						
Steam ..	9·03	14·43	6·31	0·438	0·618	0·701
S.P.S. ..	10·53	21·90	10·53	0·482	0·482	1·00
D.C.S. ..	8·77	22·18	8·77	0·403	0·403	1·00
T.P.S. ..	14·15	30·9	14·15	0·475	0·475	1·00
Motor coach						
Steam ..	12·37	17·4	4·18	0·24	0·711	0·337
S.P.S. ..	12·66	27·4	8·45	0·316	0·479	0·720
D.C.S. ..	14·53	51·4	12·2	0·218	0·290	0·85

NOTE.—(1) This table forms a key for identifying the type of any steam or electric locomotive by comparison of its characteristic ratios with those in the table.

(2) It is quite possible that two new types of electric locomotives may be evolved in the near future, *i.e.*, the high-speed express passenger and the fast goods electric locomotive. These would have characteristic ratios differing from those shown in Table II.

Analysis of Characteristics.—Having evolved a common basis of classifying electric and steam locomotives into various types, to determine their sphere of utility, the author will now endeavour to analyse the characteristic ratios and to deduce therefrom the respective merits of (1) steam locomotives, (2) single-phase, (3) direct-current, and (4) three-phase locomotives. In what follows, the initials S.P.S., D.C.S. and T.P.S. designate single-phase system, direct-current system, and three-phase system respectively, and the values of the ratios $\frac{HP}{A}$, $\frac{HP}{E}$, $\frac{HP}{W}$, $\frac{E}{W}$, $\frac{E}{A}$, and $\frac{A}{W}$ for the above will now be examined in detail.

The Ratio $\frac{HP}{A}$.—This might be called the speed efficiency ratio, because it is a measure of the speed for which the locomotive is designed, and it is therefore an index of the sphere of its utility. Table III. is an abstract of the average values of this ratio.

The conclusions that can be drawn from Table III. are:

(1) That the T.P.S. has by the far highest value of the ratio $\frac{HP}{A}$ of all types and the steam locomotive by far the lowest.

(2) That the ratio $\frac{HP}{A}$ increases with the speed for which the locomotive is designed, being highest for passenger and lowest for shunting locomotives.

The reasons for the high value of this ratio $\frac{HP}{A}$ for T.P.S. locomotives are as follows:—

TABLE III.—*Average Values of the Ratio* $\frac{HP}{A}$.

Type of locomotive.	Steam.	Electric S.P.S.	Electric D.C.S.	Electric T.P.S.
Passenger	15·4	23·7	24·78	44·2
Goods	10·96	14·34	15·40	27·8
Shunting	9·03	10·53	8·77	14·15
Motor coach	12·37	12·66	14·53	—

NOTE.—The above are average values of this ratio, but the maximum values may be much higher, especially for high-speed express passenger locomotives, for which the ratio $\frac{HP}{A}$ may be = 50 or more. Also the tendency on electric railways in future will be to raise speeds of goods trains to those of passenger trains to increase the capacity of the railway, and this will increase the ratio $\frac{HP}{A}$ for these fast goods locomotives.

(*a*) The T.P.S. motor is considerably lighter than an S.P.S. or D.C.S. motor of equal horse-power.

(*b*) The auxiliary electrical equipment required for the T.P.S. motors is lighter than that required for the S.P.S. and D.C.S.

(*c*) On the other hand, for a given duty or service, the capacity or rated horse-power of the T.P.S. motor has to be greater than that of an S.P.S. or D.C.S. motor, due to the constant speed property of the T.P.S. motor

* Inst. of Mech. Eng., November 19th.

and the necessity for providing for peak loads. This will be explained when discussing Fig. 1.

The reasons for the low value of the ratio $\frac{HP}{A}$ for steam locomotives are as follows :—

(*a*) The fact that, for a given horse-power, the weight of the motive power equipment of a steam locomotive is considerably more than that of an electric locomotive.

(*b*) The fact that part of the adhesive weight of a steam locomotive consists of revolving balance weights, whose action is to reduce the coefficient of adhesion of the steam locomotive. Consequently, the tractive effort that can be utilised is less with the steam than with the electric locomotive of equal adhesive weight, and therefore the horse-power that can be usefully applied is less also.

(*c*) The fact that the torque or turning moment of the driving wheels is not constant throughout each revolution of the wheels, but varies, whereas that of the electric locomotive is even. Consequently, the tractive effort and therefore the horse-power that can be applied to the steam locomotive is less than that of the electric locomotive of equal adhesive weight.

The Ratio $\frac{HP}{E}$.—This may be called "the efficiency of the motive power" ratio, for it measures the output or work done per unit of time for every ton of the motive power equipment. Table IV. is an abstract of the average values of this ratio.

TABLE IV.—*Average Values of the Ratio* $\frac{HP}{E}$.

Type of locomotive.	Steam.	Electric S.P.S.	Electric D.C.S.	Electric T.P.S.
Passengers	12·85	32·9	46·5	—
Goods	12·00	27·06	41·9	—
Shunting	14·43	21·90	22·18	30·9
Motor coach	17·40	27·40	51·40	—

Unfortunately, the author has not been able to obtain the weights of electrical equipment of three-phase locomotives, except for one locomotive. But it is well known that for equal horse-power the weight of a three-phase motor with its auxiliary regulating equipment, is less than that of either an S.P.S. or D.C.S. motor and equipment.

From Table IV. it may be inferred :—

(*a*) That the three-phase locomotive has by far the highest value of the ratio $\frac{HP}{E}$, and the steam locomotive by far the lowest of all types.

(*b*) That the shunting locomotives—electric—have the lowest values of the ratio $\frac{HP}{E}$.

(*c*) Notwithstanding the fact that T.P.S. motors have to be designed for a higher horse-power capacity for the same service, the weight of the electrical equipment of a three-phase locomotive is less than that of an S.P.S. or D.S.C. locomotive designed for the same service. The reason for this is that the three-phase motors take the current straight from the overhead contact wires, without the intervention of transformers used for S.P.S. motors, and with regulating apparatus weighing less than that necessary for D.C.S. motors.

(*d*) That the ratio $\frac{HP}{E}$ for a passenger electric locomotive is greater than that for a goods locomotive, and still greater than that for a shunting locomotive. This is due to the fact that high-speed motors are used for the passenger locomotives and low-speed motors for goods and shunting locomotives, and for the same horse-power a high-speed motor is lighter than a low-speed motor.

The Ratio $\frac{HP}{W}$.—This might be called the "power-weight utilisation" ratio, for it is an index of the power developed for every ton weight of the locomotive. Table V. gives the average values of this ratio :—

TABLE V.—*Average Values of the Ratio* $\frac{HP}{W}$.

Type of locomotive.	Steam.	Electric S.P.S.	Electric D.C.S.	Electric T.P.S.
Passenger	5·67	16·26	18·8	33·9
Goods	5·70	12·03	14·9	27·8
Shunting	6·31	10·53	8·77	14·15
Motor coach	4·18	8·45	12·2	—

From this table the following may be deduced :—

(*a*) That the ratio $\frac{HP}{W}$ is by far the highest for the T.P.S. electric locomotive and by far the lowest for the steam locomotive.

(*b*) That for the electric locomotive this ratio $\frac{HP}{W}$ is highest for the passenger and lowest for the shunting locomotive, the ratio being thus an index of the service for which the locomotive is designed.

The reasons for the higher value of this ratio for the electric locomotives are as follow :—First, for equal weights of equipment, the horse-power developed by the electric equipment is much higher than that developed by the steam equipment. Secondly, the dead weight such as frames, wheels, tender, coal bunkers, water tanks, required to carry the steam equipment is heavier than that required to carry the electric equipment. Consequently, the value of HP is higher and that of W is lower for the electric locomotive, so that the value $\frac{HP}{W}$ is much higher.

(3) Amongst the electric locomotives, the T.P.S. has by far the highest value of the ratio $\frac{HP}{W}$ for the reason that for the same maximum horse-power the T.P.S. motor is lighter than the others, and, moreover, requires more simple and lighter auxiliary electrical apparatus, so that the deadweight required to carry the electric equipment for the T.P.S. locomotive is also lighter.

The Ratio $\frac{E}{W}$.—This might be called "the index of the utilisation of total weight by the weight of the motive power." The higher this ratio the more effective may be said to be the motive power of the locomotive, for any given horse-power. In comparing this ratio for steam and electric locomotives, it should be borne in mind that for a given horse-power the value of E is far lower for electric than for steam locomotives. Consequently, the ratio $\frac{E}{W}$ will not materially differ. The average values of this ratio $\frac{E}{W}$ are given in Table VI.

TABLE VI.—*Average Values of the Ratio* $\frac{E}{W}$.

Type of locomotive.	Steam.	Electric S.P.S.	Electric D.C.S.	Electric T.P.S.
Passenger	0·443	0·499	0·404	—
Goods	0·476	0·459	0·358	—
Shunting	0·438	0·482	0·403	0·475
Motor coach	0·24	0·316	0·218	—

The following may be deduced from this table :—

(*a*) That the ratio $\frac{E}{W}$ is lowest for motor coaches.

The reason for this is that the weight W includes not only the deadweight required to carry the electrical equipment, but also the deadweight required to carry the passengers. The other types do not carry passengers, whereas the motor coach does.

(*b*) The ratio $\frac{E}{W}$ does not materially differ from steam and electric locomotives built for the same service, for the reasons already stated.

The Ratio $\frac{E}{A}$.—This might be called the ratio of "utilisation of motive power weight by the adhesive weight." When comparing this ratio for steam and electric locomotives, it should be borne in mind that the horse-power developed by the electrical equipment E is much greater than that developed by steam equipment of equal weight. The average values of this ratio for the various locomotives are given in Table VII.

The deductions from this table are :—

(*a*) That the ratio $\frac{E}{A}$ is highest for passenger engines and lowest for motor coaches, except steam.

(*b*) That the ratio $\frac{E}{A}$ is highest for steam locomotives and lower for D.C.S. and T.P.S. than for the S.P.S.

TABLE VII.—*Average Values of the Ratio* $\frac{E}{A}$.

Type of locomotive.	Steam.	Electric S.P.S.	Electric D.C.S.	Electric T.P.S.
Passenger	1·201	0·703	0·521	—
Goods	0·914	0·546	0·374	—
Shunting	0·618	0·482	0·403	0·475
Motor coach	0·711	0·479	0·290	—

The Ratio $\frac{A}{W}$.—This might be called "the ratio of utilisation of total weight by the adhesive weight." It is there-

FIG. 1.—*Comparison of Tractive Efforts of Steam and Electric Locomotives of same adhesive weight; each being designed for the same service.*

Tractive Effort at 16 M.P.H. = 11,720 lbs.

Equivalent to a train load of 115 tons up a 3 per cent. grade at 16 M.P.H.

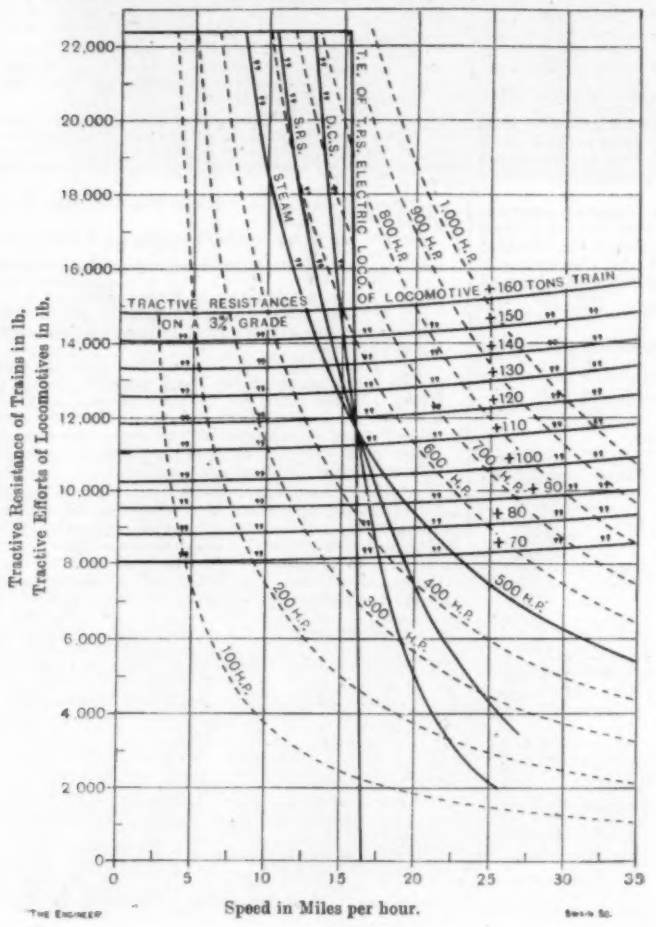
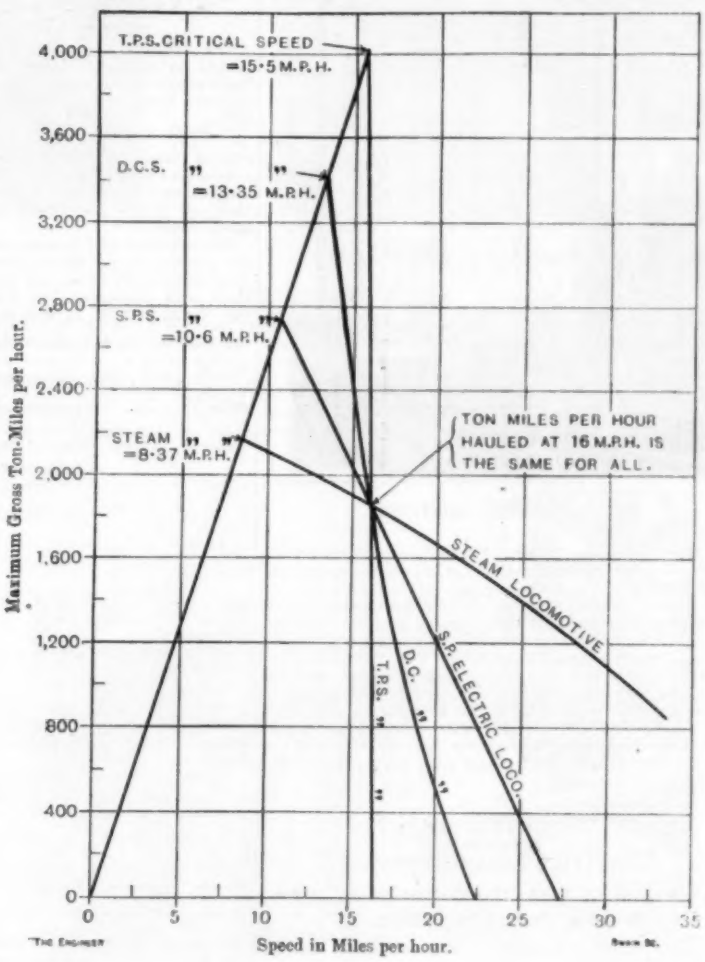


FIG. 2.—*Maximum Gross Ton-Miles per hour at Various Speeds which can be hauled by the Steam and Electric Locomotives referred to on Fig 1 up a 3 per cent. Grade.*



fore an index of the suitability of a locomotive for shunting, banking or heavy grade services for which the ratio $\frac{A}{W}$ should be as high as possible.

The average values of this ratio are given in Table VIII.

TABLE VIII.—*Average Values of the Ratio* $\frac{A}{W}$.

Type of locomotive.	Steam.	Electric S.P.S.	Electric D.C.S.	Electric T.P.S.
Passenger	0·375	0·688	0·78	0·79
Goods	0·528	0·850	0·97	1
Shunting	0·701	1	1	1
Motor coach	0·337	0·72	0·85	—

The deductions to be drawn from this table are :—

(*a*) That the ratio $\frac{A}{W}$ is highest for shunting engines and lowest for passenger engines.

(*b*) That the ratio is highest for T.P.S. locomotives and lowest for the steam locomotives.

An important deduction that may be drawn from the study of the various tables is that the S.P.S. locomotive more resembles the steam locomotive in its properties than do either the D.C.S. locomotive or the T.P.S. locomotive. The latter is radically different in its properties from the steam locomotive, as will be explained, as it has a constant speed characteristic, whereas the steam locomotive has a constant horse-power characteristic.

Comparison of the Characteristics of Steam and Electrical Locomotives.—In order to compare the characteristics of steam locomotives with those of S.P.S., D.C.S. and T.P.S. locomotives, it will be assumed that a number of hypothetical locomotives have to be designed, one of each type, with the same wheel arrangement 0–4–4–0 type, the same adhesive weight, 40 tons; and the same axle load of 10 tons. The starting tractive effort will be assumed to be the same for each and equal to $\frac{\text{the adhesive weight}}{4}$ = 22,400 lb., and the duty to be performed will be in each case to haul a trailing train load of 115 tons up a 3 per cent. gradient at a speed of 16 miles per hour.

The tractive effort at this speed for this duty will be = 11,720 lb.

The horse-power at this speed for this duty will be = 500.

The above purely abritrary assumptions have been taken to be the same for all locomotives to be compared, but in actual practice they would not be the same for all the locomotives, owing to their widely different characteristics. These conditions correspond roughly to those obtaining on the Kalka-Simla Railway, except that the locomotives considered in this comparison are approximately 66 per cent. more powerful than the existing locomotives on the Kalka-Simla Railway.

Fig. 1 has been got out to compare the respective tractive effort-speed curves of the hypothetical steam, single-phase, direct-current and three-phase locomotive referred to above.

Horse-power curves and train resistance curves have also been added to the diagram to bring out the respective properties and merits of each type of locomotive, and to furnish the data for plotting Fig. 2.

Fig. 2 has been got out from the above diagram by multiplying the speed in miles per hour by the train load in tons hauled at that speed by each locomotive, and plotting the products.

Thus the diagram shows the hauling capacity at various speeds for each of the locomotives considered. The speed at which this hauling capacity is a maximum has been termed the "critical speed" on the diagram.

The following conclusions are drawn from the analysis of the above diagrams and from the "ratios" :—

A.—*Types of Locomotives.*

(1) Passenger locomotives have the highest values of the ratios $\frac{HP}{A}$, $\frac{HP}{E}$, $\frac{HP}{W}$ and $\frac{E}{A}$, and the lowest values of the ratio $\frac{A}{W}$.

(2) Shunting locomotives have the highest values of the ratio $\frac{A}{W}$, and the lowest values of the ratios $\frac{HP}{A}$, $\frac{HP}{E}$ and $\frac{HP}{W}$.

(3) Motor coaches have the lowest values of the ratio $\frac{E}{W}$.

(4) Goods locomotives have intermediate values for all ratios.

B.—*Types of Motive Power.*

(1) The three-phase electric locomotive has the greatest maximum horse-power, the highest critical speed, greatest accelerating force start to full speed, and the least range of economical speeds and the highest values of the ratios $\frac{HP}{A}$, $\frac{HP}{E}$, $\frac{HP}{W}$ and $\frac{A}{W}$, and the lowest value of the ratio $\frac{E}{A}$.

(2) The steam locomotive has the least maximum horse-power, lowest critical speed, least accelerating power start to full speed, and the greatest range of economical speeds. It has the highest value of the ratio $\frac{E}{A}$ and the lowest values of the ratios $\frac{HP}{A}$, $\frac{HP}{E}$, $\frac{HP}{W}$ and $\frac{A}{W}$.

(3) The D.C.S. locomotive has properties and ratios intermediate between steam and three-phase locomotives, but closer to the latter.

(4) The S.P.S. locomotive has properties and ratios intermediate between steam and three-phase locomotives, but closer to the former.

A TRAIN ferry to ply on Kootenay Lake, British Columbia, is being built by Canadian Vickers Ltd. at Maisonneuve.

South African Engineering Notes.

Electrical Progress.

The statistical returns with regard to electrical progress reveal large development in municipal electrical undertakings in South Africa. The total number of units sold by municipalities during 1925 amounted to 223,604,653, as compared with 170,790,737 for the previous year. The outstanding town is Durban, where the sales increased from 41,871,922 units to 55,844,166 units, Johannesburg coming next with an increase from 44,197,556 to 54,687,593 units. Considering the relative size of the two towns, Durban's consumption is considerably greater, proportionally, than that of Johannesburg. A large increase is also shown by Cape Town, the figures being 32,881,106, as against 27,873,443 for the previous year. These three towns contribute more than half the total units sold by municipalities in South Africa. The figures given include the four Rhodesian municipalities, where a considerable increase in units sold is also shown, the total being 2,285,279, as against 1,465,668 for the previous year. Bulawayo had the greatest increase, from 725,212 units to 1,280,770, while Salisbury had an increase from 547,000 units to 769,677. Gwelo and Umtali also show substantial increases. The units sold by Councils taking a bulk supply has increased from 7,877,799 to 9,894,827. The peak load which the Cape Town electrical plant will require to carry in 1927 will be approximately 20,000 kilowatts, or, roughly, 8000 kilowatts more than during 1926. In order to cope with that demand, which is practically the maximum plant capacity now installed, and to have at the same time adequate reserve plant capacity, it is necessary to install an additional turbo-alternator of a size equal to that of the largest now in use. An order has therefore been placed with the Metropolitan-Vickers Electrical Company, Ltd., for a further 7500-kilowatt, three-phase, 12,000-volt, 3000 revolutions per minute turbo-alternator set, identical with two others supplied by that firm within the last four years, which will bring the total installed plant capacity up to 28,500 kilowatts. The contract price, which includes delivery and erection, is £21,007. The existing steam raising plant is not sufficient for the anticipated peak load, and it has therefore been decided to install two additional boilers, each of 50,000 lb. per hour evaporative capacity. The order has been placed for two Babcock and Wilcox water-tube boilers for the sum of £34,215 10s., delivered and erected on foundations to be provided by the Council. The boilers will be fitted with self-contained Green's economisers, integral superheaters, water-cooled furnace backs, chain grate stokers, and with forced and induced draught plant. One set of fans on each boiler will be driven by alternating-current motors, while the other set will be run off the direct-current system. The flue gases from both boilers will be discharged into one steel common chimney. The Municipality of Cradock is going to install a new steam station for its electricity undertaking. Glencoe township is now taking its electricity supply from the Railway Administration. Two 75 kilovolt-ampère transformers are installed. Keetmanshoop (South-West Africa) is inviting tenders for its electricity undertaking. The engines called for are vertical cold-starting crude oil units. The electrical system will be a direct-current one, with battery. Hermanus Municipality also intends to proceed with a scheme.

Locomotive Transport Ship.

A strange looking ship visited Cape Town in October, her high midship structure, very long well deck, and prominent poop and fo'castle, arousing much curiosity. She was a motor vessel named Beldis, registered at Oslo, but built at Newcastle-on-Tyne specially for carrying locomotives. There are now seven ships of this type. The Beldis had taken 14 large locomotives to Australia, and had brought back jarrah wood for Cape Town and Durban. She has a deadweight capacity of 3400 tons, and a crew of 23 men. Each of the locomotives carried on this occasion weighed 135 tons, and for lifting such weights the vessel has powerful derricks. One steel mast near the miniature funnel is capable of handling a deadweight of 100 tons.

Big Colliery Explosion.

What is probably the worst colliery disaster in the history of South Africa, which caused the death of four white men and 150 natives (Indians) occurred late on the night of Friday, October 8th, at the Durban Navigation Colliery (No. 2 mine), Newcastle, Natal. A cage coming out of the shaft at the time of the explosion, and containing five natives, was blown 60ft. into the air. Much bravery was exhibited by the rescue parties, which quickly recovered the bodies of thirty natives, but in spite of gas masks the dense fumes prevented them penetrating further than 2000ft. along the north main drive. Further attempts have since been made, but all hope of anyone being alive in the pit has been abandoned, and efforts are now devoted to restoring proper ventilation. It was estimated that it would be six weeks from the date of the explosion before conditions would be such as to enable the mine to resume its operations. In the meantime the management intends to work a double shift on the No. 1 Mine to increase the output. The cause of the explosion is, of course, unknown, but as the result of a short statement by a native who expired almost immediately after being found, it is surmised that one of the workmen in the course of adjusting the electric wires caused a short circuit, and a spark was created which caused the explosion. Many of the Natal collieries are gaseous, and great precautions have to be taken against the possibility of explosions. The Durban Navigation Collieries, Ltd., which has been in existence for fourteen years, is a company in which the Union-Castle Steamship Company is largely interested. It is probably the most up-to-date colliery in Natal, and the very latest engineering methods in coal mining have been adopted. The company is a reconstruction of a company of the same name, and its properties are equal to an area of about 17,000 acres of coal-bearing land. The Dannhauser shaft, where the explosion occurred, is about one and a-quarter miles from the main line, with which it is connected by a siding. There are three shafts. The company employs about 2000 natives and 250 Europeans. The annual output is approximately 800,000 tons, much of which is used for bunker purposes at Durban Some of it is also exported.

Buying Locomotives.

Heavy purchasing of locomotives is contemplated by the Railway Administration. Tenders, which were returnable on November 25th, were invited for fifty-two Garrett or modified Fairlie locomotives. It is evident that these special types of locomotives have so far given excellent results in service, and that they are likely to become a very important section of the Union motive power. On the same day tenders were due for three similar engines for the 24in. gauge. Tenders for the supply and delivery of two three-cylinder type experimental engines (superheater) and tenders for 3ft. 6in. gauge, 2–10–2 type are due December 2nd, 1926. Among other requirements for the South African Railways and Harbours are :—One 40-ton electric Goliath crane, tenders due November 4th, 1926; ten class 10 locomotive boilers due November 11th; supply and delivery of twelve bogie tank wagons for petrol and paraffin due November 4th.

New Type of Tender.

A Class 8 tender recently constructed in the Pretoria workshops is described in the *S.A. Railway and Harbours Magazine* for October. A departure from the shape and construction common to tenders in South Africa has been made, principally for experimental and efficiency purposes. The design was prepared at Pretoria. The tender consists of a solid cast steel underframe, diamond frame bogies, and a specially constructed tank, designed to facilitate the handling of coal by the fireman. The frames were imported from the United States, but the bogies and underframe gear and the tank were constructed in the Union. It is an entirely new departure in South Africa to have a tender built with an underframe of solid cast steel, and if this class of underframe can withstand the rough usage it will be subjected to without serious damage by breaks or cracks, it is anticipated that an appreciable reduction in repair work will result. Bogies of the diamond frame type have not been used to any great extent here in the past in conjunction with tenders, but the claims for them are undoubtedly strong, and it was decided to ascertain their value in tender work in this instance. The arch bars, which constitute the main frame, are 4½in. by 1¼in. in section. The wheels and axles are interchangeable with the standard bogie wheels for this class of tender. The axle-boxes, which are of cast steel, are arranged to take a radial type slipper with a loose brass bearing. The bolster casting is also of steel and is ribbed to withstand the somewhat severe stresses imposed from time to time. The centre bearing and side friction blocks are all detachable, being secured to the bolster with bolts. The bolster rests on two sets of elliptical bearing springs, each set consisting of three springs. The tank is of unusual design and is arranged with the coal to the fore end and water to the rear end. Space for 10 tons of coal and 3000 gallons of water is provided. The weight of the tender, in full working order, is approximately 43 tons. This weight is fairly evenly distributed over the bogies, and the weights on each bogie under varying quantities of coal and water show satisfactory results. The leading dimensions are as follows :—20ft. 1in. over headstock; 10ft. bogie centres, with 5ft. 7in. wheel base; and 2ft. 9½in. diameter wheels, with 9in. by 4in. diameter journals. The width over the frame is 8ft. 5½in.

A Ship-repairing Job.

Two important repairs to two steamers have recently been effected by James Brown, Ltd., of Durban. The first comprised the removal of the propeller shaft, brass liner and 15ft. of stern tube of the Union Government steamship Seattle without docking the ship, the stern being elevated by filling the forward hatch with some hundreds of tons of coal. A new liner and tube, the latter weighing 4 tons, were cast, machined, and fitted and the propeller re-fixed, the whole job occupying a fortnight. A new steel mainmast, 40ft. long and 5 tons in weight, and two red pine derricks, each weighing over 1½ tons, were made and fitted to the ss. Middlemoor, which steamer arrived at Durban with only her foremast in position, the mainmast, derricks, &c., having been accidentally uprooted by her steam winch and damaged beyond repair while the vessel was being loaded by native labour in Djibouti Harbour.

A MAGNETIC AXLE-TESTING DEVICE.

To facilitate the detection of hair cracks in the axles of Underground rolling stock, a new magnetic axle testing device has recently been installed at the Acton overhaul works. It consists of two cast iron frames, connected at their bases by a tiebar upon which the energising coils are placed. The axle is mounted on brass rollers, but two face-plates in the magnetic circuit are locked flush with its extremities. Upon energising the coils a closed magnetic circuit is formed by way of the tiebar, the side frames and the axle. Any flaw that is otherwise undetectable in the axle at once becomes evident, owing to its imparting a tendency for a magnetic potential difference to be set up across the fracture wherever the latter cuts the prevailing flux. A mixture of fine iron filings and paraffin is poured over the axle and the filings adhere to the crack and become piled up in a thick black line that is easily discernible.

It is now the practice at Acton works to test all axles for hair cracks as soon as they are sent in for periodical overhaul and before operations such as tyre turning are carried out on the wheels. This obviates any chance of an axle with hair cracks being put back into service, only to be scrapped soon afterwards, when the cracks have developed sufficiently for them to be detected in the course of the three-weekly examination to which all axles on the Underground are subjected.

A WATER WHEEL WORKED BY THE SEA

A Curious Water Wheel.

The accompanying illustration, which represents a curious water wheel, has been sent to us by John Blake, Ltd., of Accrington, Lancs., which had received it from one of its clients in the Piræus. The mill is in Cephalonia, one of the islands of the Ionian Archipelago, in Greece, and is near the principal town of Argostoli. It is curious because it is worked by the flow of the sea running inland and not *vice versâ*. The distance from the shore to the wheel is about 50 yards, and the fall is about 4ft. After the water has passed the undershot wheel it disappears amid the clefts and fissures of limestone, of which the land is formed. In the illustration the water is seen flowing towards the wheel.

The question will naturally be asked, "Where does it go to then?" And so far there is no entirely satisfactory answer. It appears that during the British occupation of the islands, the authorities poured into the sea water large quantities of petroleum, and surrounded the island with boats to find signs of floating oil on the sea surface, but none appeared. It is supposed by some that the water sinks into the depths of the earth and comes out in the form of steam through volcanic vents.

The horse-power derived from this fall is at present ten, but the energetic proprietor of the mill is continually digging into the fissures of limestone to find fresh openings into which the water might run, thereby increasing the current of the flow, as well as the horse-power of the wheel. He has already succeeded in increasing what was originally only 4 horse-power to its present figure.

EDMUND GUNTER.

On December 10th, 1626, three hundred years ago, there died in the Old Gresham College in Bishopsgate-street, the Rev. Edmund Gunter, known to all land surveyors for his invention of the "Gunter's Chain." Since 1615 Gunter had been the incumbent of St. George's, Southwark, then surrounded by the Marshalsea, the King's Bench, and other prisons, and since 1619 he had also been Gresham Professor of Astronomy. He was a distinguished mathematician, the friend of Henry Briggs, and in 1620 published the first printed table of artificial sines and tangents. The work was entitled "Canon Triangulorum, Sive Tabulæ Sinuum Artificialium ad Radium 10,000,000, et ad Scrupula Prima Quadrantis." To astronomers Gunter is also known for his invention of the sector and a portable quadrant, while he was the discoverer of the alteration in the variation of the magnetic compass. The son of a Welshman of Gunterstown, Brecknockshire, he was born in Herefordshire in 1581, but was educated at Westminster School and Christ's College, Oxford, taking the degrees of B.A., M.A., and B.D. The introduction of Gunter's chain, 22 yards long with 100 links, was an important step in the history of land surveying, for it replaced the wooden rods used since the earliest days. The fundamental unit of land measurement is the acre, and this we had from the Romans. Their words "ager" and "pertica" gave us those of acre and perch. The acre was the area of land which could be ploughed by a pair of animals in one day. Practice gradually led to the acre being regarded as a strip 220 yards long and 22 yards wide, the measuring rod being the perch, of 5½ yards, a quarter of the shorter side, and the area of the acre was 160 square perches.

The earliest statute dealing with land measurement which has come down to us was drawn up in the reign of Edward I., and in this the acre is defined in its length and breadths for seventy different rectangles. The units of length, the furlong, or furrow-long, and the mile were defined by an Act of Elizabeth, which stated "a mile shall contain eight furlongs, every furlong 40 poles, and every pole shall contain sixteen foot and an half." Though the acre is traced to the Romans, the Saxons used another unit known as the "hide," which seems to have been the quantity of land, made up of proportions of arable, hay and feeding land, which was sufficient for the maintenance of a man and his family. With the coming of the Normans the acre was reintroduced, but all measurement till Gunter's time was by rods. Gunter described his chain in 1623, calling the links "Centesmes." With this the area of the acre was ten square chains; the square chain contained 10,000 square links, and the acre 100,000 square links. Thus by measuring in chains and "centesmes" or links or decimals of a chain, the area result appeared in acres and decimals of an acre. Gunter was only forty-five years of age when he died, but his works were collected and various editions of them have been published.

The Institution of Civil Engineers.

OCTOBER EXAMINATIONS, 1926.

PASS LIST (*INTERIM*)

(*Subject to confirmation by the Council*).

Preliminary (49).—L. R. J. Absolon, W. B. Acton, R. A. H. Allen, G. C. Archer, T. B. Birchenough, A. H. Blow, J. H. Burke, G. F. Clifford, K. E. Cotton, C. Le B. Daman, E. Dixon, R. S. Drake, R. Elliott, N. Ellis, T. L. Farnes, H. R. Farrington, J. F. Griffiths, B. W. Hadfield, G. S. Hill, R. Inglis, J. E. Irvine, V. Johnson, W. L. Jones, M. W. Lashmar, P. W. Loveday, J. B. Lund, T. L. Maccabe, J. C. Martin, S. D. Mitchell, P. R. Nath, W. G. Neat, C. J. Norris, W. L. Osborne, W. H. Pink, J. W. Pope, K. A. Pope, W. G. Ramsay, H. A. Robinson, C. W. Sass, H. V. Steggles, B. W. Sutherns, D. I. Todman, L. G. Tucker, G. M. Vibart, G. E. Walker, H. Wallhouse, W. F. Wegener, A. K. Wilson, F. L. Wright.

Associate Membership (185).—*Whole Examination* (*Sections A, B and C* (4).—W. C. Andrews, R. Johnson, G. H. Kempton, F. J. Lancaster.

Sections A and B only (12).—A. G. Boulton, J. Dosser, L. A. Drain, P. B. Fasham, J. N. Flitcroft, G. L. Goulden, J. Izatt, H. Miller, H. V. Phillips, W. T. Rondel, G. T. Starling, R. F. Stocks.

Sections A and C only (2).—E. G. Dale, H. P. Sadler.

Sections B and C only (11).—F. W. Adie, J. H. Barton, N. H. Hunt, G. S. Lindsay, J. Matthews, A. A. Ragg, W. D. G. Rees, J. MacM. Riddet, P. H. Selbie, F. A. Shorter, L. McI. Winchester.

Section A only (46).—W. Booth, C. V. Brown, J. Campbell, G. A. Cessford, W. C. Clarke, R. M. Crichton, D. W. Currie, E. R. Davies, G. Downing, W. G. Dunstan, H. H. Evans, J. W. S. Fawcett, T. D. Hackney, H. B. Hall, H. L. Hammond, L. Hammond, A. A. Heath, F. Hewson, J. V. Jackson, J. E. Johnson, J. A. Johnston, C. L. Kennir, S. A. Lambert, M. H. Limb, D. W. McGregor, W. McIntyre, G. H. Marwood, J. C. Morris, A. G. Naldrett, T. M. Niven, D. M. O'Neale, J. L. Parkinson, B.Sc. (Edin.), R. P. Radcliffe, W. E. Roberts, E. L. Rushbrooke, R. E. Sadler, W. J. Scott, J. M. Simpson, D. G. Skitt, C. H. Smith, H Snape, P. A. Turner, J. H. Walker, C. V. Williams, N. S. Williams, F. L. Wooldridge.

Section B only (30).—A. Adlington, E. B. Allinson, W. G. Beeson, J. N. Deason, J. A. L. Denison, T. Donkin, G. J. Ellis, H. M. Everett, G. A. M. Gentery, R. A. Harrison, N. B. Henderson, F. F. Hixson, D. Holdsworth, E. Hoyte, S. Juleff, M.C., J. McE. King, C. C. Knowles, O. C. Llewelyn-Jones, G. H. F. Lutter, J. MacNiven, J. D. Malcolm, H. Milne, H. F. Noyce, F. C. T. Nutter, W. T. P. Perkins, G. Slater, M. J. Wardle, J. S. Whyte, D. B. Wood, N. Worrall.

Section C only (80).—A. R. Adams, B.Sc. Eng. (Lond.), M. E. Adams, J. F. A. Baker, A. W. Ballantine, B.Sc. (Glas.), R. S. Bamber, B.Sc. (Manchester), N. Barnard, A. C. Beever, B.Sc. (Edin.), H. Black, B.Sc. (Edin.), L. Bown, R. C. Bracken, B.Sc. (Durham), C. A. Bradley, B.Sc. (Manchester), J. Bryan, B.Eng. (Sheffield), W. E. J. Bugden, B.Sc. Eng. (Lond.), L. Carnie, G. H. Causey, B.Sc. (Manchester), J. K. Clinch, B.A. (Oxon), R. V. Collman, B.Sc. Eng. (Lond.), R. F. Davis, B.Sc. Eng. (Lond.), J. C. Dickinson, B.E. (New Zealand), C. B. Eck, P. Eckersley, R. H. Edwards, W. B. Farrow, B.Sc. (Wales), H. M. Finlay, B.A. (Cantab), M. Giles, B.A. (Cantab), J. F. Gourlay, B.Sc. (Glas.), C. R. Grixoni, B.Sc. Eng. (Lond.), C. Haddon, B.Sc. (Glas.), W. Hamilton, A. L. Handley, B.Sc. Eng. (Lond.), J. C. Hargreaves, B.Eng. (Sheffield), G. Hebson C. W. Hewlett, B.Sc. Eng. (Lond.), C. Heyes, B.Sc. Eng. (Lond.), C. E. Hollinghurst, B.Eng. (Liverpool), T. Holt, B.Eng. (Liverpool), L. M. Howard, E. Hutton, R. T. James, D. W. Jones, B.Sc. (Leeds), O. Kean, C. R. Kinton, A. N. Lechler, B.Sc. (Edin.), J. E. Lewis, J. Long, J. McAdam, P. M. B. McBain, A. K. Mackereth, A. M. Maddox, B.A. (Oxon), A. H. D. Marwick, B.Sc. (Manchester), W. L. D. Martyn, B.Sc. (Manchester), A. P. Mason, B.Sc. Eng. (Lond.), D. Melville, J. Miller, B.Sc. (Glas.), J. A. Ogden, B.Sc. (Manchester), A. L. Owen, C. S. P. Randel, B.A.I. (Dublin), M. A. Read, B.Sc. Eng. (Lond.), C. A. Risbridger, B.Sc. Eng. (Lond.), H. S. Roe, B.Sc. Eng. (Lond.), R. Rose, B.Eng. (Liverpool), H. Samuel, B.Eng. (Liverpool), D. A. N. Sandifer, B.Sc. Eng. (Lond.), C. F. N. Seaman, J. H. F. Sharkie, B.A.I. (Dublin), S. W. Slight, B.Sc. (Bristol), H. S. Smith, B.Sc. Eng. (Lond.), J. Speedy, B.A.I. (Dublin), C. R. Stone, L. G. Taffs, B.Sc. Eng. (Lond.), H. R. Tasker, B.Sc. Eng. (Lond.), W. K. Taylor, B. N. Wallis, B.Sc. Eng. (Lond.), S. G. Wardley, B.Sc. Eng. (Lond.), F. J. Watkins, A. G. Wheeler, T. Willey, R. J. Williams, E. R. Wilson, B.E. (National), H. Wolf.

The results of the examinations held abroad will be announced later.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

General Conditions.

With output from the coalfields becoming more normal, the confidence of Midland industrialists in future trade prospects is increasing. There is business in plenty waiting to be placed, but until there is reasonable assurance of delivery at prices which the business will stand, negotiations have no outcome. Nevertheless, the Midland market shows more activity, and the tone is more optimistic, an expansion in trade being anticipated as supplies of raw materials increase. On 'Change in Birmingham to-day—Thursday—producers of iron and steel quoted higher prices for material than buyers were willing to concede. Midland smelters whose blast-furnaces are idle were not prepared to name prices.

Mining Situation.

While the miners' councils in the Midlands are busily engaged in arranging conferences with the mine-owners to consider the question of setting up district agreements, the workers are returning in greater numbers to the pits. They have been idle too long, and consider there is nothing further to be gained by remaining out. How satisfactorily matters are progressing in this district is shown by the fact that there were, at the time of writing, approximately 200 more miners employed in the West Midland coalfield than prior to the dispute, while at Cannock Chase nearly 20,000 miners, out of a total of 25,000, are at work to-day. In Nottingham, of course, employers and employed have already come to terms, and, what is more, have made their treaty for five years. Warwickshire miners' officials are seeking to get into touch with the owners. Though in this area most of the men long ago returned to work, their position at present is simply that they have temporarily and provisionally accepted the owners' terms—they have, that is, no formal agreement. It is the considered opinion of industrialists hereabouts that the local arrangements ought to be as generously conceived as economic conditions in the various districts permit; for now that there exists a prospect of getting back within a reasonable space of time to something like normal conditions, the country needs stability above all else. There is no room within the general scheme of settlement for local arrangements which leave the men persuaded that they are drawing from the industry less than is their due. If we are to have peace in the coal industry for any length of time, then the men must be persuaded that they have obtained the best terms the industry is capable of conceding.

Constructional Engineering.

The appreciation of prices under the abnormal strain to which industry has been subjected by the coal conflict has had the effect of holding up business. Contractors who have based their estimates on normal conditions would be courting ruin if they went ahead irrespective of inflated costs. They are accordingly waiting till prices have subsided. That the conclusion of the mining dispute will change the aspect of the market is certain, but it is not at all certain that prices will recede as quickly as sanguine forecasts suggest. Midland engineers state that the advance in prices is such that constructional and marine engineers are not likely to conclude new contracts of much account before the New Year. There is a good deal of business, they report, in view for the shipyards, but progress in that department is further deterred by the dearth of steel and other constructional material.

Steel Plate Competition.

Colonel Sir William Charles Wright, Bart., chairman of Baldwins, Ltd., alluded to the severity of continental competition, especially in steel plates, at the annual meeting of the company in Birmingham on the 19th inst. His remarks have occasioned considerable disturbance in Midland industrial circles. Sir William stated that the heavy bar mill and heavy plate mill of the company had been closed down since September of last year, owing to the keen competition in foreign heavy plates, and sectional material. Steel plates had been coming into this country, he said, at prices far below the average cost of manufacture here, and unless some legislation was introduced to counteract the dumping of heavy steel goods, there seemed to him small prospects for the future of the heavy steel trade. The company, however, is hopeful that when the coal strike is over and conditions become more normal, it may be able to obtain orders which will enable it to start up the heavy bar mill, but the prospects for the heavy plate mill are at present not promising.

Lost Steel Contracts.

It is reported in the Midlands this week that, owing to the difficulty and almost impossibility of obtaining firm quotations for coal supplies in January, a well-known Staffordshire firm has lost two large orders for Indian railway bridges representing at least 3000 tons of steel. The contract, it is understood, was kept open for some weeks to enable a quotation to be given, but was eventually abandoned, owing to the impossibility of forecasting the cost of the steel in the absence of price tenders for coal. The order, it is stated, has gone to Germany. Industrialists hereabouts state that a good deal of business is being lost in this way.

Bilston Steel Works.

From inquiries made this week, it seems very improbable that the large South Staffordshire steel works of Alfred Hickman, Ltd., Spring Vale, Bilston, will resume operations this year. The chief difficulty in the way of starting up, of course, is the shortage of coke. It was pointed out that the works were absolutely dependent upon a regular and adequate supply of coke, and at present

none of the coke ovens had been set going. Even when they made a commencement there would be a rush for supplies from other large concerns, and under the best conditions not much hope of the works recommencing before the New Year was to be held out. A prominent official of the firm stated that, following the termination of the coal strike, the steel trade seemed like being busy for some time. The prospects were undoubtedly better, and prices showed some little improvement.

Pig Iron Prices.

Interest on 'Change in Birmingham to-day centred chiefly round future pig iron prices. For many months no Northampton or Derbyshire iron has been available and the restarting of furnaces is an event keenly looked forward to. Price speculations are the subject of inquiry. It will be possible, it is thought, to buy Northampton or Derbyshire iron at about £4 12s. 6d. The cost, with delivery to Birmingham, would be £5 2s. 6d. It is unlikely that Midland brands of pig iron will be plentiful for some time. The restarting of coke ovens will be a slow business, especially if the coal succeeds in maintaining anything like the present big figures. Weeks must elapse before the furnaces turn out normal quantities and qualities even when coke is forthcoming, and the usual estimate is that no Midland, or for that matter additional British pig iron, need be looked for this year. Apart from limited consignments from Cleveland and Durham, the pig iron used in the Birmingham foundries, most of which have been kept going fairly well, is imported. Demand for French pig iron is good, and the quotation for January delivery is approximately £5 12s. 6d. The market is very quiet, however, for prompt delivery is the vital consideration, and this can rarely be assured. If it can be, then premiums on the high rates nominally prevailing are not a barrier to business. No. 3 Cleveland foundry pig has been sold here up to £7 in cases where it could be got without delay through second hands.

Steel.

Though every effort is being made to restart the heavy steel mills, it is feared some time must elapse before supplies are available. Light steel supplied by the re-rollers continues to be turned out in fair quantities, and Midland re-rollers having this week secured some continental billets, are working at high pressure to deal with the heavy rush of orders on hand. Two additional mills have been put into operation this week. There is no change in the price basis, so far as there can be said to be any basis in the unstable conditions which now prevail. Small steel bars are quoted up to £9. Future prices mentioned for structural plates are £8 17s. 6d. and £9, but it is really futile to try to pre-determine the course of the market as long as so little is known about costs. Additional steel works are becoming more willing to quote prices, because, in such cases, the firms own their own collieries. Most of the big steel works have half a year's work on hand for joists, plates, &c. The call for foreign steel and semi-finished material is brisk, but complaints regarding shipping delays are still prevalent. Importers offer soft billets at from £6 6s. to £6 10s. Foreign structural steel is, in some departments, slightly lower in price.

Finished Iron.

The position in the Staffordshire finished iron trade remains unchanged, and its future activity is indeterminate. Everything depends upon the rapidity with which other branches of industry get on to their feet again. The few bars being rolled go to supply special customers. None come on to the open market. Nut and bolt production in the Black Country is more restricted. No. 3 Belgian bars are offered at from £6 14s. to £6 17s. 6d. delivered, but few new orders are being given out.

Galvanised Sheets.

Galvanised sheets are now pretty firmly established on the £17 15s. basis for 24 gauge corrugateds. Most of the mills have sold practically all their output over the rest of the year, and a fair amount of business has been booked for January and February. Inquiries indicate that recent buying has not satisfied demand.

The Future of Industry.

Mr. P. J. Hannon's remarks on the future of industry at a recent gathering in Birmingham express very much the optimism of industrialists in many Midland trade circles. They are in entire agreement with him in his statement that now the unfortunate industrial strife through which they had been passing was coming to a close, he saw a great hope for the industry of this country. They would like to believe with him that for the next two or three years they would have an industrial revival, far more stimulating and profitable than in any similar period during the last hundred years. Mr. Hannon warned them not to build high hopes upon its continuity, but he contended that if we were assured of ten years' permanent peace between employer and employed, we could look forward to a period in which our prestige as a great industrial and trading nation would be established for all time.

Trade Returns.

Midland iron and steel masters and engineers on 'Change to-day expressed their satisfaction at the trade returns for the past month. It was considered remarkable that, despite the fact that the iron and steel industry has been more grievously hit by the lack of cheap and abundant fuel than any other industry, it should have exported more in October than in any month since July. The aggregate of 194,065 tons, value £4,214,539, compared with 160,218 tons, value £3,358,337, in September. Shipments of pig iron, as was only to be expected with but five furnaces in blast throughout the whole kingdom, continued to shrink, but finished material of many descriptions was more largely exported. The instances in which the previous month's figures were not improved upon were few. The galvanised sheet trade continued to make headway, sheets being sent out to the amount of 59,614 tons. This was an increase of nearly 17,000 tons on September, and was within 7000 tons of the big total recorded in October of last year. On the other hand, it was noted that the amount of foreign iron and steel imported was not so large as in September, the tonnage falling from 445,704 to 398,235, and the value from £3,327,312 to £2,979,284. Imports are, however, nearly double those of a year ago. Rather less pig iron came in than in the previous month. Steel blooms, billets and slabs represented an aggregate of 90,048 tons, against 99,145 tons. Sheet bars and tin-plate bars, 86,360 tons, were much above the August figure, but did not quite equal the heavy imports of September. There was a decided drop in steel girders, beams, joists, pillars and many products in which South Staffordshire specialises.

Birmingham's Exports to America.

Exports from the Birmingham district to the United States ordinarily fluctuate widely. In the abnormal conditions which prevail some loss of momentum is inevitable. The consular returns for the quarter ended September show an increase of 161,176 dollars over the value of the exports in the second quarter, but the comparison with the corresponding quarter of last year is less satisfactory, the total value of the trade, 1,947,170 dollars, being 235,198 dollars less.

Birmingham to the Sea.

The Birmingham Corporation's proposal for improving inland water communication between the city and the sea, was discussed at a recent meeting in Birmingham of the Executive Committee of the National Council for Inland Waterways. The Committee expressed the opinion that the maintenance and localised development by gradual stages of water communication between the city and Bristol was preferable at the present time to the larger scheme, and appointed a deputation to meet the Birmingham Chamber of Commerce.

Obituary.

The death took place on Thursday last, after a short illness, of Mr. John Fellows, of Compton Grange, Cradley Heath, a well-known figure in the industrial life of South Staffordshire. Mr. Fellows, who was eighty-four years of age, was one of the largest chain manufacturers in the area, and the founder of the Clyde and Mid-British Chain Works, Cradley Heath. For twenty-five years he acted as secretary of the South Staffordshire Chain Manufacturers' Association.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Back to the Mines.

THE last vestige of doubt as to an early end to the seven months' stoppage of the coal mines seems now to have been removed. This is the general feeling in the Lancashire district, and it seems to be sufficiently substantiated by the accelerated rate at which the miners in the Lancashire and Cheshire fields have been returning to work this week on the terms which the owners have been offering for some time. What the official district terms will be is not known at the time of writing, although little time has been lost since last week-end's developments in attempting to arrive at a basis of settlement. A conference of Lancashire and Cheshire coalowners and the miners' representatives was held here on Tuesday under the presidency of Colonel Lionel Pilkington. Normally in the official area of Lancashire, Cheshire and North Wales about 114,500 men are employed in the pits. Of that number not many short of 70,000 are already back, so that the change that has taken place locally during the past week or two is easy to see. The effect is already clearly reflected in the fact that industries are able to secure coal supplies on very much better terms than last week—at 55s. a ton, compared with 65s.—although the published statement that there is "almost a glut" may be accepted as an indication of enthusiasm rather than of fact.

Locomotive Shop Wages.

On behalf of locomotive and carriage shop men employed by the Cheshire Lines Committee and the Great Central section of the London and North-Eastern Railway, a claim has been entered which, it is estimated, if granted will entail an additional expenditure of £90,000 yearly, about 7200 men being affected. The basis of the claim is that the decision No. 728 of the Industrial Court should be applied to various classes of men in this area. With the exception of the lines mentioned above, the decision is in operation on all British railways. Something like 4500 men employed in the locomotive shops at Gorton, Manchester, and in the carriage works at Dukinfield, are paid at the Manchester district rate and work under the agreed district conditions. At other centres the men receive the district rates but do not work under district conditions. At certain other places there is a special Great Central rate. The Court of Inquiry agreed to postpone any decision until after January 1st next, when the application will be considered.

Textile Machinists.

There has been rather a firmer feeling in textile machinists' shares during the past few days, to a large extent presumably due to the improving prospects in the cotton manufacturing industry. For several years now the cotton industry has been anything but active, and the result has been reflected in the domestic demand for textile machinery, although during a large part of that time there has, on the whole, been a fairly active demand from overseas markets. This, however, has shown some sign of slackening off within the last few months so far as new business is concerned. It is interesting to note, by the way, that Platt Brothers and Co., Ltd., of Oldham, have declared an interim dividend of 2½ per cent., which is at the same rate as for each of the two previous years.

New D.Sc.'s.

Honorary D.Sc. degrees of Manchester University were conferred last week upon Mr. S. L. Pearce and Mr. A. E. H. Tutton. Dr. Pearce, who was formerly chief electrical engineer and manager to the Manchester Corporation, resigned that position about eighteen months ago on becoming an Electrical Commissioner, on the invitation of the Government, and has just been appointed engineer-in-chief to the London Power Comapny. He was at one time assistant engineer to the British Thomson-Houston Company, Ltd., and superintendent engineer to the Central London Railway Company. He began his career with the Electrical Engineering Corporation, West Drayton, and later served with Richardsons, Westgarth and Co., Hartlepool. Dr. Tutton, F.R.S., is well known for his research work in the science of crystallography. He is a former student of Owen's College, Manchester, the forerunner of the present University.

Non-ferrous Metals.

Tin has again been the most active section of the non-ferrous metals market, and a further substantial advance in values has to be recorded, the metal remaining exceedingly firm at the moment. The trade demand for tin is rather quiet, and in this country especially is much below normal, and has been for several months. Galvanising works, however, are known to have substantial orders in hand, and a marked increase in buying activity from this direction may reasonably be expected in the next few weeks, so that some support to the market is looked for. The position of copper has not changed very much during the week, and up to last week-end a slight gain was registered, although this was lost in the early days of the present week. The trade demand for this metal is only of moderate dimensions, but the statistical position is regarded as not being unsatisfactory. The consumption of spelter in this country has suffered considerably as the result of the coal dispute, and here, again, an improvement is looked for before long. In the meantime, prices keep fairly steady, and on balance there has been little change compared with a week ago. There has been a fair demand for lead, and values here have been maintained.

Iron.

There is no lack of speculation in the pig iron market as to when a resumption will be possible at the blast-furnaces. Everything depends, of course, upon coke supplies, and these, in turn, are largely dependent upon the prices that coal as such is realising on the market, for they are high enough at the present time to offer a big inducement to the colliery companies to sell their slack rather than turn it into coke. It is expected that conditions will be more or less normal before long, and some iron makers are anticipating being able to start accumulating supplies of coke in readiness for a resumption of operations at the furnaces in about a month. Meanwhile buying of spot offers of pig iron is limited, but prices are maintained in view of the very restricted supplies, with quotations for delivery into this district at about £7 per ton for Scotch No. 3; £6 17s. 6d. for Middlesbrough; £6 12s. 6d. for East Coast foundry iron; and about £6 for parcels of off-grade hematite. There is little current demand for continental pig iron, offers of which range from £5 15s. to £6 2s. 6d. per ton delivered, but in not less than six weeks. There has been a resumption at some of the bar iron works and others are hoping to follow suit almost immediately, coal being obtainable now at much lower rates than were being asked a week or two since. Crown bars can be bought now at £12 10s. per ton delivered, both for prompt and forward, with seconds quoted at £11 5s. per ton.

Steel.

The steel market is displaying signs of continued firmness, and this week higher prices have been asked by several makers. It is expected that firmness will characterise the market for some time now in view of the fact that most producers have enough work in hand to occupy them for several months, and in view of the fact also that buyers will be extremely anxious to secure early supplies. For boiler-plates quotations are about £11 10s., with ship-plates at £8 12s. 6d. to £8 17s. 6d., joists and sections at £7 17s. 6d. to £8 2s. 6d., and basic bars at £9 to £9 7s. 6d. per ton, delivered Manchester. Although preparations are under way for restarting rolling mill plant, there is little definite information yet as to when actual supplies will be available. The Indian demand for galvanised sheets continues quiet, but prices show no change at £17 10s. per ton f.o.b. for the usual specifications for this market. In one or two instances offers in second hands are made at as much as £1 per ton less than this without securing orders. Continental deliveries of steel materials are taking from two to three months to complete, and, under the circumstances, it is not surprising that orders are much fewer and of less weight than they were a month ago. There has been little change in prices, however, billets being quoted at £6 5s. to £6 7s. 6d., wire rods at about £7 5s., steel bars at £6 15s., sheet bars at £6 10s. to £6 12s. 6d., light plates at £7 10s., Siemens plates at £7 15s., and joists and sections at £6 15s. to £6 17s. 6d. for delivery to works in the Manchester area for net cash against shipping documents.

Scrap.

There is only a quiet business passing in non-ferrous metal scrap, but values are pretty much as they were a week ago, with brass rod turnings at £40 per ton, selected gun-metal scrap at £52, light copper at £57, zinc at £25 10s., and lead at £29, delivered to users' works.

Institution of Mechanical Engineers.

There was a splendid gathering of members of the North-Western Branch of the above-mentioned Institution at the Engineers' Club, Manchester, on Thursday, 18th inst., to hear Professor Coker, F.R.S., deliver his Thomas Hawksley lecture on "Elasticity and Plasticity." Mr. Cecil Bentham, chairman of the branch, presided. Although probably few of his listeners were able to follow

the Professor's mathematical explanations of the subject without having previously seen a copy of the lecture, the numerous diagrams and natural colour photographs, which were shown on the screen, gave a graphic explanation of the many phases of the subject, which was much appreciated.

BARROW-IN-FURNESS.

Hematite.

It is a case of waiting now for the men in the various coalfields to come to agreement with the mine-owners. Once a solid agreement is reached then fuel will be available, and the ironworks in this district can get to work. The way things are shaping does not look like a restart before the New Year, and yet makers are anxious to begin on the heavy orders which they hold, and which will keep them occupied for the better part of a year. Not only in ordinary qualities is the demand good, but there is a healthy prospect for the special qualities which most of the makers turn out. The market is quite firm, and if there was a further spurt in placing orders the price might rise. It is not unlikely.

Iron Ore.

The iron mines have had a very quiet time for a long period, and latterly they have been practically idle; but when the furnaces are in blast again, there will be a period of activity which most of them have not experienced for several years. It is not known yet as to whether the freight charges will be up on foreign ore. In a week or two it will be time to discuss that.

Steel.

The steel makers are not badly placed for orders, but the contracts are not as bulky as those for iron. Most of the orders were placed some time ago, and little business has been done recently, or the market would have shown it by the prices rising. The hoop mills have been engaged all through the stoppage, and there is every evidence of there being a busy time in the future, in view of cheaper cotton and a bigger demand for hoops. In addition to the American requirements, there is quite a good trade with Africa, most of the cargoes going to Mombasa.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

A FEW more furnaces have been re-commissioned this week, including two by Vickers Ltd., and one by John Henry Andrew and Co., Ltd., Toledo Steel Works, and this fact can be taken as a sign of the movement towards a normal resumption of trade. The rapidity with which works will get back into full swing will vary considerably, but the majority of steel makers will have to wait some weeks for the delivery of the necessary material. Activity is also likely to be restricted until fuel becomes cheaper. All present quotations for forward business show a considerable advance on pre-stoppage figures. Bar iron is 20s. a ton higher, billets 10s. a ton, pig iron 8s. 6d. a ton, coke 7s. 6d. a ton, and coal 2s. 6d. a ton. These advances are a serious matter for the finished trades, and particularly for engineers who have to meet foreign competition. The steel workers of Sheffield, many thousands of whom are out of employment, have been heavily hit this year, but it will be January before those who were working before the general strike can be re-absorbed. There is plenty of work in hand, but all the heavy departments are held up for want of material. At the same time, when the great difficulties that have faced the iron and steel trades since May are remembered, the manner in which the works have kept going is really remarkable. Considerable ingenuity and enterprise have been shown in meeting a position which has changed from week to week, but unfortunately heavy financial burdens have necessarily had to be incurred.

Engineering Work.

Three Sheffield firms have received contracts for the supply of permanent way special track work for the Manchester Corporation tramways. The work consists chiefly in the making of tramway junctions and other special point work. The firms which have secured these contracts are the Titan Trackwork Company, Ltd., Rutland-road; Edgar Allen and Co., Ltd., Imperial Steel Works; and Hadfields, Ltd., Hecla Works. Another large batch of orders is to be placed for railway material. The South Indian Railway has invited tenders for twist drills, wire ropes, cast iron pipes and pig iron, and the Madras and Southern Mahratta Railway Company is seeking delivery of eighteen short-circuited rotor motors, complete with pulleys, slide rails, &c. The Bengal and North-Western Railway is in the market for five locomotive tenders, and the Director-General of the India Store Department has invited tenders for two electric travelling cranes and for steel bolts and nuts. Sheffield Corporation is seeking power for the construction of new tramways.

The Lighter Trades.

Owing to the quietness of the engineering industries throughout the country, there is not a very brisk trade passing in engineers' tools, yet at the same time prices show a tendency to increase. Edge tools are selling well, both at home and abroad, there is a good call for all classes of tools for the building trades, and now that the collieries are preparing to get to work again, the general overhaul of stock has brought plenty of orders for renewals. The motor trade continues to buy well in the special steel and tool departments, and here, fortunately, there is no shortage of material. Except in a few cases the cutlery, silver and electro-plate works are experiencing an unusually quiet time, and even the work that is in hand is practically profitless. Several firms have been able to get hold of substantial contracts which are enabling them to work full time, but those who are depending on orders coming through the ordinary trade channels are having a lean time. Shopkeepers are buying very sparingly, and in order to get business prices have to be cut to the bone. Under normal conditions the cutlery and plate trades should now be enjoying a season of comparative prosperity, but instead there is as much, if not more, unemployment than is the case during the summer months when these trades expect to have a quiet time.

Colliery Topics.

Each week sees a marked improvement in the supply of fuel, and such large quantities are coming on to the market that it is felt that there should be a relaxation of the restrictions so that freer supplies should be available for industrial purposes. The coke position is unsatisfactory, which is a source of some anxiety in view of the necessity for getting the much-needed supplies of pig iron. The Staveley Coal and Iron Company is re-lighting another thirty coke ovens, which will give it sixty-five in operation, and it is proposed to bring a number of blast-furnaces into operation. One of the most interesting items of news has been the announcement that the Tinsley Park Colliery Company, Ltd., Sheffield, has become associated with the newly formed Rotherham and District Collieries Association, Ltd., a coal-selling agency. The companies now in the group are John Brown and Co.; Dalton Main Collieries; United Steel Companies and Tinsley Park Colliery. Mr. J. Hazel, secretary of the Tinsley Park Company, has been appointed director and secretary of the new Association.

Road Building.

Sheffield roads have earned quite a reputation for their wear-resisting properties, and road engineers in districts which have a preponderance of very heavy traffic will find much to interest them in the annual report of the Sheffield city surveyor. Asphaltic surfacing has become practically the standard for Sheffield roads, except where severe gradients or other special conditions necessitate special treatment. Experimental lengths of different composition are constantly being laid, with the idea of perfecting the system. There is no doubt, according to the report, that the introduction of asphalt has been one of the main factors in reducing road costs. A bituminous compound has now been devised for painting the surface of asphalt and so prolonging its life, in the same way that surface treatment has added to the life of tar-macadam. A suitable compound for an asphalt surface, however, was not easily found, and this matter has been the subject of considerable experimental work. After trying the painting of white lines and several other methods, stainless steel studs, manufactured in the city, have been adopted as the standard for marking out the centre of the roadway at dangerous and difficult curves. Although in the first place these studs cost more than painting, in the long run they are more economical than repeated renewals of the paint. They are quite effective, and show up in weather when a painted line could not be seen at any distance. It has been reported to the Wortley Council that the scheme for a new road from High Green to Birdwell, which will open out a shorter route between Sheffield and Barnsley, has reached such a stage that there is now nothing to prevent the County Council making a start on the road. The estimated cost is £128,500, towards which the Unemployments Grants Committee is to contribute 75 per cent. of the interest and sinking fund charges.

Thorne Bridge Scheme.

The West Riding County Council has prepared a scheme for the construction of a bridge for heavy transport entering Thorne. The bridge, for the construction of which permission is being sought, would be 30ft. wide, and would cost nearly £19,000. The expenditure would be met by the Ministry of Transport, which would contribute 65 per cent., the Sheffield and South Yorkshire Navigation Company, which would give £1000, and the West Riding County Council, which would find the balance.

Electricity Application.

Desirous of extending its generating station, Mexborough Council has applied to the Electricity Commissioners for sanction to borrow £20,000 for the purpose. Since 1921 the Council has been taking a supply from the Yorkshire Electric Power Company, but the case for the Council is that the charges are higher than the cost at which the extended Mexborough station could generate current.

NORTH OF ENGLAND.

(From our own Correspondent.)

Making a Start.

THE possibility of getting the iron and steel works in the North of England restarted is now being widely discussed. Everything points to a gradual resumption, and though it is possible that some of the works will be able to get going again in a week or so, active steps are not likely to be taken until after the Christmas holidays. The extent of the coal supplies remains so undependable, for the moment, that iron and steel manufacturers are moving with due caution in the task—an expensive one—of making preparations to resume. Until the situation in the coalfields has cleared definitely, that is bound to be the guiding principle. On the other hand, a prompt return to the pits and the development of a spirit of conciliation would rapidly benefit the heavy industries. In many cases this week steel furnaces have been "warmed up" in anticipation of an attempt to resume operations next week.

Trade Prospects.

In the North there is a feeling of quiet optimism regarding trade prospects. It is clearly realised that a keen fight lies ahead of the Northumberland and Durham coal exporters to regain lost markets; but, with prospects of a settled peace, it is believed that the export trade will show sufficient resiliency to re-establish itself very soon. In the shipyards and engineering works the outlook is distinctly brighter. Those industries have been passing through a period of unexampled gloom, but it is generally admitted that the tide is now on the turn, and that, when supplies of fuel and materials are available, there will be a welcome revival. Iron and steel manufacturers, in common with their workmen, are impatiently awaiting the time when they can settle down to work again; and, if that time is not too long delayed, there seems to be a period of great activity in store. There is certainly a big volume of work to be put in hand when fuel supplies are once again normal, but the extent to which there will be a speedy resumption at the steel works will depend entirely upon the course of coal prices. The rush for coal when the pits are again producing on normal lines is sure to be heavy, and the warning of the Federation of British Industries asking manufacturers not to attempt to build up reserves until such time as the abnormal demand has been met, is considered as very necessary in the circumstances. As it is, the demand for fuel will send up the price of coal beyond an economic figure at first, and until it comes down to what may be termed the normal post-stoppage price, iron and steel manufacturers will hesitate before restarting idle plant. Some substantial orders for steel have been placed, and, with the accumulation of deliveries under old contracts, a good volume of work is assured for a time at any rate. In the case of blast-furnaces, it will take at least six to eight weeks to get back to full blast again, and thus it is likely to be the turn of the year before a really marked improvement takes place in the pig iron trade.

More Pits Resume.

Now thoroughly disillusioned, the more thoughtful of the Durham and Northumberland miners appreciate the fact that they could have obtained infinitely better terms six months ago than they will now have to submit to. Large numbers of men have returned to work this week without waiting for the terms of settlement to be arranged. Seven more pits have been reopened in Durham and five in Northumberland. It is believed in trade circles that by next Monday there will be a large output, and by the following Monday a full resumption at the pits, though roof falls here and there may have to be made good and other repairs be necessary after so long a cessation of work underground.

Cleveland Iron Trade.

Quite an optimistic tone prevails on the Cleveland pig iron market. It is generally felt that, once things settle down again, there will be a brisk period of activity. This week there have been plenty of consumers willing to place big orders at what they consider a reasonable figure, but the position is still much too uncertain for producers to commit themselves. It is generally agreed that there can be no very substantial output of iron and steel this year. Fuel must first be assembled at the works in sufficient quantities to ensure continuity of operations. Then the processes of warming up the coke ovens and of restarting the blast-furnaces cannot be rushed, and there will certainly be many blast-furnaces which will not be producing iron until the turn of the year. Moreover, most of the pig iron producing plant is the property of steel makers who, themselves urgently needing iron, will naturally have first call on the output. All things considered, therefore, the prospects are that for some time to come pig iron will be scarce and dear. When, however, large-scale production is possible, Cleveland should speedily regain its export trade, as the re-valorisation of the franc has driven up continental prices at a rapid rate, and British makers seem at long last in sight of the time when they will be able to compete successfully on level terms. Prices are unchanged, No. 1 Cleveland foundry iron being 125s.; No. 3 G.M.B., 120s.; No. 4 foundry, 119s.; and No. 4 forge, 118s. 6d.

Hematite Pig Iron.

There are no quotations for East Coast hematite pig iron, but makers indicate about 90s. as a probable basis of business when production is resumed.

Ironmaking Materials.

Ore merchants still report no business, and it is impossible to quote a c.i.f. price owing to high freight rates.

Manufactured Iron and Steel.

The steel manufacturers have made no further change in the "official" minimum prices, though they are not prepared to do business except at a premium. Preparations are being made in all the works for a re-start, and a number of furnaces are already in action. Others will be started as quickly as may be, as there is an enormous pressure for material of all descriptions, and the numerous orders recently placed for new ships promise renewed activity for a branch of the industry which has long been under a cloud.

The Coal Market.

Business on the Northern coal market is in abeyance, operators being doubtful as to the forward position. The output is very considerable, and under present market conditions owners have difficulty in clearing it. Merchants are pursuing a cautious policy in anticipation of a rapid reduction in prices following the first rush of supplies. No coal prices are indicated, but about 25s. per ton is expected to rule for good average qualities for the whole of next month. Gas coke is scarce and firmly held for home domestic use at 60s. per ton, but no forward export prices are quoted. It is estimated that when work is fully resumed, the collieries will require about two-thirds of what used to be the normal number of employees.

SCOTLAND.

(From our own Correspondent.)

Position Improving.

With the miners returning to work in considerable numbers even without awaiting district agreements to be concluded, the general outlook is gradually improving. As fuel becomes cheaper the way to the reopening of workshops and factories will become clearer, and at the moment it seems likely that this result will not be long delayed now. Practically everything depends on the price of fuel, assuming a level sufficiently low to allow of production on a competitive basis after the work which is already in hand has been disposed of. Business, on the whole, has been on recent lines, but there is evidence that markets anticipate a more lively time in the near future.

Shipbuilding Contracts.

Napier and Miller, Ltd., Old Kilpatrick, have received an order for two cargo steamers of 9000 tons each from Sir William Reardon Smith, the Cardiff shipowner. The machinery for these vessels will be supplied by David Rowan and Co., Ltd., Glasgow.

Steel and Iron.

Conditions in the steel and iron trade are still under the influence of the coal trade situation, especially in respect to the existing price of fuel. Obviously, some time must elapse before all difficulties can be surmounted and trade proceed on normal lines. Many works are fairly comfortably situated as regards orders on hand, and as fuel becomes cheaper work for some time ahead is assured. Meanwhile there is little change from recent conditions. Outputs are comparatively small, and consumers are either utilising imported materials or purchasing only absolute requirements. Heavy steel is still almost unobtainable, and sections are also extremely difficult to secure. Steel sheets, both black and galvanised, are particularly well booked and prices are firmer. The two bar iron works in operation at present still concentrate on the production of steel bars manufactured from foreign billets. Bar iron consequently is very scarce and firm in price. All the pig iron furnaces remain idle. It is stated that some pig iron producers have considerable contracts to fulfil, and are therefore compelled to abstain from using high priced fuel. Coal will have to become much cheaper before the pig iron furnaces can restart. Only small quantities of foundry pig iron are now available from stock, and high prices are obtained for these odd lots.

Coal.

There has been no appreciable change in the coal market during the past week. Supplies have been in excess of demands, and in view of increasing outputs, consumers have preserved a very cautious attitude. Many are withholding orders, while those buying are restricting purchases to immediate requirements. Prices are weakening, Lanarkshire screened steam coal being obtainable at from 37s. 6d. to 40s. per ton. For the first time for a while now washed stuffs were quoted, the prices being as follows: —Double nuts, 35s.; single nuts, 32s. 6d.; pearls, 30s.; and dross, 25s. to 30s., all per ton f.o.t. at pit. Moderate quantities of Scotch coal have been sold for trawler bunkering at about 40s. per ton, and it is said that shipments for the south of England have been arranged at a similar figure. House coal is selling in the west of Scotland at from 3s. 3d. to 3s. 6d. per cwt., and at 3s. to 4s. per cwt., according to quality, in the east of Scotland.

American Coal.

The Government agents in Glasgow have now succeeded in disposing of all American coal which they have on board at Glasgow docks. Three steamers are in dock, and the cargoes have been almost unsaleable for some days, therefore the securing of a good market for the fuel must be a matter for considerable gratification.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Position.

There has been an improvement in the daily rate of miners returning to work in South Wales, and the figure now reached is over 32,000, which is about one-seventh of the total number of workmen who were engaged in the coalfield prior to the stoppage at the end of April. Fears have been entertained that the old saying that "first out and last in" would again be applicable to the miners of South Wales, but it may be that the daily increase in the flow back to work may have the effect of speeding up a settlement on the part of the leaders. There is no doubt that the extremists are still doing their best to restrain the men from going back, and at some of the collieries many men who have been at work have been persuaded to come out again and await a general settlement; but in spite of this, the daily total of miners employed rises, and by the end of this week it is probable that the number will have reached 40,000. The men are displaying more readiness to work in the steam coal area than in the anthracite district, where comparatively few have resumed. There is certainly more coal about, as is shown by the fact that permits are not now necessary in the case of coals for home consumption. This is a great relief to all who are engaged in the supply of coals, but so far as exports are concerned the embargo is still in operation, and this means that next to no business can be done for the shipment of coals to foreign destinations. A few steamers have been chartered, and in one case the steamer is ready in dock to load, but no release of the cargo can be obtained, notwithstanding that there are coals standing. The Government is, from all accounts, very determined that there shall be a plentiful supply of coals for home use; but many consumers are not purchasing more than their most pressing requirements, so that the demand is not so extensive as might have been expected. A few shipments have been effected of cargoes of coal for United Kingdom ports, but if foreign exports are to be prohibited there seems little doubt that stocks of coal will accumulate as outputs increase to such an extent that, whether by design or otherwise, so far as the Government is concerned, prices will probably experience a sharp fall, and chaos will prevail. As a protest at the action of the Government authorities in adopting a "tightening-up" policy in the distribution of coal, Mr. Finlay Gibson, the secretary of the South Wales Coalowners' Association, has written to the Secretary of Mines and resigned his offices as secretary to the Coal Emergency Committee, as Divisional Coal Officer for Monmouthshire and South Wales, and as a member of the Shipment Emergency Committee. In the course of his letter, Mr. Gibson states that he cannot conscientiously co-operate in the carrying out of arrangements which he is convinced can only be detrimental to the South Wales coal trade, to the district generally, and to the workmen employed at the collieries.

Coal Regulations.

At the end of last week colliery companies in this district received notification from the secretary to the Coal Emergency Committee that that body had decided, in view of the gradually increasing output, that the system of permits should be withdrawn as from last Saturday. The Committee at the same time made it quite clear that priority must still be given to the essential services. Permits were also abolished from the same date for the removal of coke by rail, and it was announced that coal could be shipped from the Bristol Channel to any ports in the United Kingdom, including the cross-Channel services, without any restrictions, and all British railway companies are now allowed to obtain unlimited quantities of coal from South Wales. It was also notified that there are no restrictions on bunkers for fishing vessels or for approved coasting services. The circular informed colliery owners that the Mines Department was prepared to give sympathetic consideration to applications for limited quantities of bunkers for foreign-going vessels, but the Mines Department is not prepared to allow exports at the present time, though it will give consideration to the matter when the output increases. Inquiries show that up to the present no releases have been granted for coals for foreign export, but release has been given for supplies of bunkers in the case of steamers which are going abroad to load cargoes of coal for delivery in the United Kingdom.

Coal Negotiations.

Immediately following on the national delegate conference in London last week when the resolution put forward by the Welsh representatives was approved, this being for negotiations in the districts, steps were at once taken for a meeting to be arranged of the Conciliation Board for South Wales. This meeting was called for Tuesday afternoon. After a couple of hours' discussion, the meeting was adjourned to Wednesday. Since the six points were published, constituting the guiding principles laid down by the Miners' Executive for the framing of district agreements, fears were held that some of them at least would prove an insurmountable obstacle to agreement, notably that relating to the period for which agreements are to operate. It was regarded as ridiculous to stipulate for agreements to be terminable by one month's notice on either side, and it was expected that the owners would stand for a three years' agreement at least. The six points did not, however, include the question of hours, which on all hands was expected to be a formidable one; but the unexpected has happened in this respect, and the coalowners' representatives and the miners' representatives on the Board have agreed to an eight-hour day for five days in the week and a six-hour day on the Saturday. It is strange that after all these weeks of strife, this question has been solved on these lines. Reference was made a couple of months ago in this letter to the fact that this would be the solution of the hours' problem, viz., a forty-six hours' week.

Later.

Contrary to my previous message no agreement has been come to between the South Wales Coalowners and miners' representatives on the question of hours. The conference which opened on Tuesday was adjourned until Wednesday, but at about mid-day it was announced that negotiations had broken down.

Prices.

Colliery companies have been informed this week that it has been agreed by sales agents that as from Tuesday last the fixed price for coals for household purposes should be 50s. per ton for large and 45s. for through coals, these prices being at pit, but in the case of coal for other purposes the prices of 50s. for large, 45s. for through and 35s. for smalls, all at pit, should be maximum prices. All the above prices mark a reduction of 5s. per ton, which has been made on the distinct understanding that the merchants will give the public the benefit of the reduction, viz., of 3d. per cwt. As regards business on the market in coals, sales have been effected of fresh-wrought Welsh coals for bunker purposes, viz., vessels trading coastwise at 42s. 6d. to 45s. per ton for large, while owners of steamers going to foreign destinations have had to pay 60s. for American coals for use as bunkers.

Working Hours at Docks.

An important conference of every section interested in the work at the South Wales docks was held at Cardiff this week, when it was agreed that it was imperative that two split shifts of from 8 a.m. to 5 p.m. and from 9 p.m. to 6 a.m. should be introduced, and that the employers of the workmen concerned should be supported in any action they may take to bring about this arrangement. The present hours of work are 6 a.m. to 2 p.m. and from 2 p.m. to 10 p.m. The suggested new working hours give a longer interval between them, and it is contended that this would be advantageous from the point of view of enabling the traffic to be better organised, and thus lead to speedier shipments.

Colliery Merges.

Apart from the merging of the Amalgamated Anthracite and the United Anthracite collieries, which may also include the Henderson group, the report is current in coal trade circles that a movement is on foot for the amalgamation of the Ocean Coal undertaking with the Powell Duffryn Company, and that Lambert Brothers, Ltd., may also be involved in it. There is no confirmation of the report, which if it did mature would mean, including debentures, a total capital of over 12 millions.

CONTRACTS.

Ransomes and Rapier, Ltd., of Ipswich and 32, Victoria-street, Westminster, London, S.W. 1, have received an order from Richard Dixon and Co. (Eastburn Quarries), Ltd., of Cross-hills, Keighley, Yorks., for a steam shovel for work at their quarries.

Cammell Laird and Co., Ltd., Birkenhead, have received an order from Messrs. S. C. Chambers and Co., Liverpool, on behalf of the Lancashire Shipping Company for two vessels of 9000 tons deadweight fitted with Diesel engines. The vessels are intended for the New York and Far Eastern trade.

Ferranti, Ltd., of Bush House, London, W.C. 2, has received from its Australian agents an order for nineteen 11,000 kilovolt-ampère (B.E.S.A. rating 12,500 kilovolt-ampère) single-phase transformers to form 33,000 kilovolt-ampère three-phase banks. These transformers are for the new Bunnerong Power Station of the Sydney Municipal Council.

The Harland Engineering Company, Ltd., of 72–74, Victoria-street, Westminster, S.W. 1, has received from the London, Midland and Scottish Railway Company an order for three rotary convertor equipments for the Carron Dock sub-station at Grangemouth. Each equipment will comprise a 150-kilowatt rotary convertor, transformers and starting gear, and will be used for operating dock cranes.

Ransomes and Rapier, Ltd., of Ipswich and 32, Victoria-street, Westminster, S.W. 1, have received the following orders: —(*a*) From the Rhodesia Railways, Ltd., for two Ransomes-Rapier-Marion steam-operated dragline excavators; (*b*) for one steam dragline for the New Zealand Public Works Department; (*c*) for a similar excavator for the Punjab Public Works Department; and (*d*) for two others for Messrs. Noyes Brothers, of Sydney, N.S.W.

Spencer (Melksham), Ltd., of Melksham, Wilts., has received the following orders:—(*a*) For the complete equipment of the new Post Office, now being built by the Union of South Africa, consisting of conveying machinery for the handling of mail bags, parcels, &c.; (*b*) for the whole of the dust extracting plants for four terminal grain elevators at Bahia Blanca, from the Buenos Aires Great Southern Railway Company; and (*c*) for two pneumatic travelling elevators for discharging steamers together with the steel gantry work and conveying plant to feed a new grain warehouse at Leith, from the Leith Harbour Commissioners

The Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Ltd., has received from the Gas Department of the Borough of Bolton an order for a further installation of Woodall-Duckham continuous vertical retorts for its Gas-street works. The new bench, which will comprise twenty-four retorts, is to have a total carbonising capacity of 198 tons per day. The order includes coal-handling machinery a rotary wagon tipper and a waste heat boiler. The same firm has also received from the Wolverhampton Gas Company an order for a third installation of Woodall-Duckham continuous vertical retorts, comprising four settings, each of four retorts and one producer. The new plant will have a nominal daily carbonising capacity of 112 tons per day. The contract includes coal and coke-handling plant and a waste heat boiler.

LAUNCHES AND TRIAL TRIPS.

Cremer, motor ship; built by the Netherland Shipbuilding Company; to the order of Koninklyke Paketvaart Maatschappy; dimensions, 390ft. by 52ft. by 27ft. 6in.; 8050 tons displacement. Engines, two single-acting 4-cycle; constructed by Werkspoor, Amsterdam; trial trip, October 26th.

Kenton, steel screw steamship; built by the Tyne Iron Shipbuilding Company, Ltd., of Willington Quay, Newcastle-upon-Tyne, to the order of Arthur Stott and Co., Ltd., of Newcastle-upon-Tyne; dimensions, 355ft. between perpendiculars by 50ft. 6in. by 26ft. 4in. deep moulded; to carry a deadweight of about 6600 tons. Engines, triple-expansion, 25in., 41in. and 65in. by 45in. stroke, pressure 180 lb.; constructed by the North-Eastern Marine Engineering Company, Ltd., of Wallsend; launch, November 20th, 1926.

University of London, University College.—In connection with the Centenary Appeal of University College, the students have arranged to hold a soirée and exhibition on December 3rd and 4th, on the first day from 3 to 9 p.m., and on the second day from 2 to 7 p.m. On Friday a dance will be held in the large drawing-office and a concert in the Engineering Society's room; on that day, too, half-hour lectures will be given. Professor J. A. Fleming will speak on "Electrical and Mechanical Oscillations," and Dr. Garner on "Liquid Air," whilst Captain Plügge, an old student, will describe his recent motor car trip from London to Constantinople to test the efficiency of wireless apparatus for sending and receiving messages from the car during the journey. This car and equipment will be on view in the quadrangle. A great variety of mechanical, electrical and hydraulic experiments will be shown, such as the testing of engineering materials, the towing of ship-shape models, the application of polarised light to show the stresses in bridges and the action of cutting tools, cyclical temperature variation in a gas engine, X-ray track apparatus, electric spot welding, rotating magnetic fields, stroboscopic effects, and the like.

Archæological Engineering.—On Monday last Lieutenant-Colonel E. Kitson Clark delivered a lecture to the graduates of the Institution of Mechanical Engineers at Storey's Gate. His subject was Archæological Engineering, and he dealt with it in that happy vein of his which has made him so popular as a lecturer in many parts of the country. The lecture was illustrated by numerous excellent lantern slides, showing civil and architectural engineering works of the Egyptians, Assyrians, Romans and Greeks. Perhaps the most interesting of them was one showing the tomb of a famous architect in which there is a wonderful carving of a lifting-pole with its guys and hoisting tackle. The lecturer dealt with this slide in detail, and explained the many numerous features of interest which it exhibited. At the conclusion of the lecture the applause was loud and prolonged, and the audience was surprised to find that an hour and a-half had slipped away almost unnoticed. A vote of thanks was proposed by Professor Cohen, and seconded by the President, Mr. Reavell, who occupied the chair. In responding to it, Colonel Clark referred to some wonderful experiments with exceedingly high magnetic flux, which he had shown at Cambridge on the preceding evening.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	—

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	—	—
No. 1 Foundry	‡4 15 0 to 5 0 0	—
No. 3 Foundry	‡4 10 0	—
‡ *For delivery after resumption of work at furnaces.*		
N.E. Coast—		
Hematite Mixed Nos.	*No quotation.*	
No. 1	„ „	
Cleveland—		
No. 1	6 5 0	6 5 6
Silicious Iron	6 5 0	6 5 6
No. 3 G.M.B.	6 0 0	6 0 6
No. 4 Foundry	5 19 0	5 19 6
No. 4 Forge	5 18 6	5 19 0
Mottled	5 17 6	5 18 0
White	5 17 6	5 18 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—	*(None offered.)*	
Foundry No. 3	3 5 0 to 3 10 0	
„ Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	*(None offered.)*	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	*(None offered.)*	
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 15 6 (*a*)	—
	4 18 6 (*b*)	—
	5 2 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	11 0 0
Best	—	—
N.E. Coast—		
Common Bars	11 15 0	—
Lancs.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 5 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—	*(Prices nominal.)*	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ¼in. and up *d*	8 2 6	7 0 0
Sections	7 12 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	12 0 0 to 13 0 0	
Sheets (Gal. Cor. 24 B.G.)	—	£17 10 0 to 18 10 0

(d) Official Minimum, actual prices about 5s. more.

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 12 6	—
Angles	8 12 6	—
Boiler Plates	12 0 0	—
Joists	8 0 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	9 10 0	—
„ (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
„ (Soft Steel)	10 15 0	10 15 0
Plates	8 12 6 to 8 17 6	
„ (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	7 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	8 15 0 to 9 5 0	
Billets and Sheet Bars	—	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 15 0 to 18 0 0	
Angles	8 12 6 to 8 17 6	
Joists	8 12 6 to 8 17 6	
Tees	9 12 6 to 10 17 6	
Bridge and Tank Plates	—	
Boiler Plates	—	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/6 to 25/6
Block Tin (cash)	316 10 0
„ (three months)	302 10 0
Copper (cash)	57 0 0
„ (three months)	57 17 6
Spanish Lead (cash)	29 7 6
„ (three months)	29 13 9
Spelter (cash)	33 13 9
„ (three months)	33 13 9
Manchester—	
Copper, Best Selected Ingots	65 0 0
„ Electrolytic	65 15 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price) lb.	0 1 1
Brass Tubes (Basis Price) lb.	0 1 0
„ Condenser lb.	0 1 2½
Lead, English	31 0 0
„ Foreign	29 15 0
Spelter	33 15 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9½ to 1/10½ per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c. „	£22 0 0	7/3
„ „ 8 p.c. to 10 p.c. „	£20 15 0	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 0 0	12/6
„ „ „ 1 p.c. „	£43 0 0	15/-
„ „ „ 0·70 p.c. carbon	£54 0 0	17/6
„ „ „ carbon free	1/5d. per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£10 17 6 scale 5/- per unit	
„ „ 75 p.c.	£16 5 6 scale 6/- per unit	
„ Vanadium	14/9 per lb.	
„ Molybdenum	5/1 per lb.	
„ Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

	(*Prices nominal.*)	Export.
Lanarkshire—		
(f.o.b. Glasgow)—Steam		15/9
„ „ Ell		16/6
„ „ Splint		16/6 to 17/-
„ „ Trebles		15/9
„ „ Doubles		14/- to 14/6
„ „ Singles		13/9
Ayrshire—		
(f.o.b. Ports)—Steam		16/9
„ „ Jewel		17/- to 17/6
„ „ Trebles		17/-
Fifeshire—		
(f.o.b. Methil or Burntisland)—Steam		12/6 to 14/9
Screened Navigation		21/-
Trebles		14/- to 15/-
Doubles		14/-
Singles		13/- to 13/6
Lothians—		
(f.o.b. Leith)—Best Steam		14/- to 14/3
Secondary Steam		13/6
Trebles		14/6 to 14/9
Doubles		13/6
Singles		13/6

ENGLAND.

	Inland. (*Nominal, none on offer.*)	Export.
(8) N.W. Coast—		
Steams		*No quotation.*
Household		„ „
Coke		„ „
Northumberland—		
Best Steams		16/-
Second Steams		14/6 to 15/-
Steam Smalls		8/- to 8/6
Unscreened		13/- to 13/6
Household		20/- to 22/-
Durham—		
Best Gas		18/6 to 19/-
Second		15/- to 15/6
Household		20/- to 22/-
Foundry Coke		18/- to 20/-
Sheffield—		
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	26/- to 28/-	—
„ „ House	24/- to 25/-	—
„ „ Large Nuts	17/- to 20/-	—
„ „ Small	12/6 to 14/-	—
Yorkshire Hards	17/- to 19/6	—
Derbyshire Hards	16/- to 19/-	-
Rough Slacks	10/- to 12/6	—
Nutty Slacks	7/6 to 9/-	—
Smalls	3/6 to 6/-	—
Blast-furnace Coke (Inland)*	—	—
„ „ (Export)	f.o.b.	16/- to 17/-

(9) SOUTH WALES.

	(*All prices nominal.*)
Cardiff—	
Steam Coals:	
Best Smokeless Large	35/- to 40/-
Second „ „	30/- to 35/-
Best Dry Large	30/- to 35/-
Ordinary Dry Large	30/- to 32/6
Best Black Vein Large	30/- to 35/-
Western Valley Large	30/- to 35/-
Best Eastern Valley Large	30/- to 35/-
Ordinary „ „	30/- to 35/-
Best Steam Smalls	25/- to 26/-
Ordinary „	20/- to 22/6
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	35/- to 40/-
„ „ Smalls	21/- to 25/-
No. 2 „ Large	30/- to 32/6
„ „ Through	25/- to 27/6
„ „ Smalls	20/- to 25/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	35/- to 40/-
Pitwood (ex ship)	40/- to 42/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals:	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

A Critical Recovery.

It has always been regarded as essential to a continuance of industrial activity that the revalorisation of the franc should proceed by stages so that industry would be able to adjust itself gradually to the new conditions. The improvement that has taken place is much greater than is desired in the interests of trade. If the recovery is really due to circumstances which tend to a permanent improvement it is difficult to see how its progress can be controlled effectively, and when it is seen that the franc is well on its way to partial revalorisation, the chances are that the improvement will be accelerated by public confidence. That confidence can only be based upon the conviction that the appreciation is justified. All industrial classes are, therefore, extremely uneasy over the turn events have taken. While the franc has improved in value there is generally a hardening of prices of raw material, owing largely to the higher cost of coal and coke. In view of the prevailing uncertainty, business is practically at a standstill, and what makes the situation more critical is the absence of inquiries for export. Under present conditions it is becoming more and more difficult to do a foreign trade.

Coke and Anthracite.

The Welsh anthracite trade has always depended largely upon the demand for fuel for slow combustion stoves which are employed almost generally in France, as well as in many other continental countries. So long as Welsh anthracite was obtainable there was no question of employing anything else, for despite its higher price it was more convenient to handle and more economical than the anthracite obtained from Belgium and elsewhere. When, however, the miners' strike deprived users of supplies they had to look for substitutes, and they are now employing Ruhr anthracite, which is said to give equally good results and to be cheaper. In many cases also, Welsh anthracite has been replaced by foundry coke for domestic heating, and there again the economy is so great that users have no intention of returning to anthracite. It therefore appears that one result of the miners' strike will be a considerable reduction in the demand for Welsh anthracite on the Continent.

Hydraulic Works on the Congo.

The only immediate solution of the problem of developing transport in the Central African Colonies lies in utilising the river Congo, which is navigable for the greater part of its length, but for a distance of 250 miles it is a succession of rapids with a difference of level between Stanley Pool and Matadi of 300 m. If this obstacle were overcome the Congo would be a great highway through Central Africa, and it would be possible to carry out the work of colonial development under economical conditions. The way in which that might be done was explained to the Société d'Encouragement pour l'Industrie in Paris by Major Van Deuren, of the Belgian Army. The problem presents great difficulties, since it involves the construction of barrages across a river in which the flow of water is at the rate of 30,000 cubic metres a second. Major Van Deuren affirms that they would provide energy representing the formidable total of 100 million horse-power. This could be done by constructing between Stanley Pool and Matadi seven barrages 30 m. high and 1 kilom. long. Piers from 6 m. to 8 m. by 30 m. would be sunk in the river, and on those piers would be laid a metallic bridge which would form part of an armoured concrete dam with sluice gates allowing a flow of from 30,000 to 70,000 cubic metres of water a second. In each of the seven barrages it is proposed to install at first two turbines each of 50,000 H.P. A ship canal would be constructed alongside with locks, each having a rise of 40 m., similar to those on the Panama Canal. It is estimated that the time required to carry out this vast scheme would be from fifteen to twenty years, and the cost would be close upon a milliard gold francs, but Major Van Deuren believes that it would bring in eventually 100 million gold francs a year as the result of the improved traffic. A similar return could also be secured from the utilisation of half a million horse-power, which is only a very small part of the total that would be available if this scheme for regularising the Congo were carried into effect.

Unemployment.

The almost entire absence of unemployment in the metallurgical trades has so far been a sign of activity, which could only be maintained by an importation of foreign labour, but, at the present moment, there is a change in the situation that may possibly give rise to a labour problem. Men are being discharged from some of the big factories, and in others they are working a fewer number of hours. It is hoped that this will be merely temporary. Already the Labour Department has to take into consideration the interests of French workers as opposed to those of foreign labourers who have come into this country by arrangement with foreign Governments under conditions which insure an equality of treatment.

Foreign Trade.

Although the returns of foreign trade continue to show an unfavourable balance, it is nevertheless being steadily narrowed down by the increasing exports during the past five months. This may be attributed no doubt to the miners' strike in Great Britain, for the imports of coal from other countries have not compensated for the cessation of imports of British coal, and, for the same reason, there has been a considerable increase in the exports of iron and steel to England. During the first ten months of the year the imports were valued at 49,397 million francs, an increase of 15,409 million francs, and the exports totalled 48,810 million francs, an augmentation of 12,089 million francs. In tonnage the imports amounted to 38,032,827 tons, a decrease of 1,427,609 tons, and exports reached a total of 26,951,121 tons, an increase of 1,827,032 tons.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

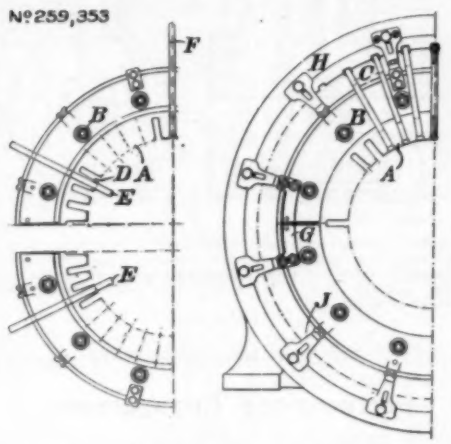
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

259,353. August 29th, 1925.—Improvements in and relating to Dynamo-electric Machines. The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Frank Percy Whitaker, of 237, Clifton-road, Rugby.

The object of this invention is to provide a construction of stator which will be inexpensive to build and at the same time will simplify the problem of insulating the windings when extra high voltages are being used. A represents the stator core, comprising laminations of annular form clamped together by



means of bolts B and split into halves. Coils C, previously wound on a former, are passed through the splits in the laminations and threaded over the core, and then finally inserted in slots D in the core. In the left-hand drawing the position of a coil as it is being passed over the laminations is indicated at E, and a coil in position in its slot is indicated at F. The halves of the core are then joined together by members such as G to form the complete core and mounted in a frame H, in which it is supported by means of brackets J. These brackets are made non-magnetic unless they are placed two pole pitches, or a multiple thereof, apart.—*October 14th*, 1926.

TRANSMISSION OF POWER.

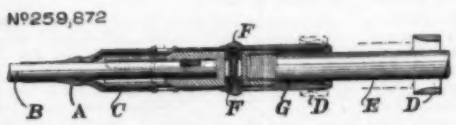
254,308. June 22nd, 1926.—Improvements in or relating to Hollow Electric Cables, Siemens-Schuckertwerke Gesellschaft mit beschränkter Haftung, of Berlin-Siemensstadt, Germany.

The subject matter of this invention is a hollow cable with a support made from a flat band or strip, which possesses slight thicknesses, so that it is very light, can be twisted in short coils or windings, and has a very high moment of resistance to crushing. The specification reads as follows:—"According to the invention, this is attained by the fact that as support use is made of a thin strip of metal, which is corrugated, at least in the centre. The higher the corrugations of the strip, the shorter may its windings be. In comparison with a support made of non-corrugated flat band, its windings can easily be made about one-half shorter. At the same time the corrugation of the band has the advantage that the support has a high moment of resistance in the radial direction, so that it cannot be crushed together. The two longitudinal edges of the support can, when being wound, stretch in comparison with the centre of the bank, and are thus secured against high strain by traction. The longitudinal edges of the corrugated support may also be somewhat turned over, so that the conductor wires when being twisted together have a surface presented to them upon the support and not a sharp edge." The illustration reproduced accompanies the specification, but no reference is made to it.—*October 21st*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

259,872. June 16th, 1926.—Tube Rolling Mills, A. Nowak, 100, Prinz Georgstrasse, Düsseldorf, Germany, and Mannesmannrohren-werke, Berger Ufer 1b, Düsseldorf.

This invention relates to the rolling of seamless tubes in pilger

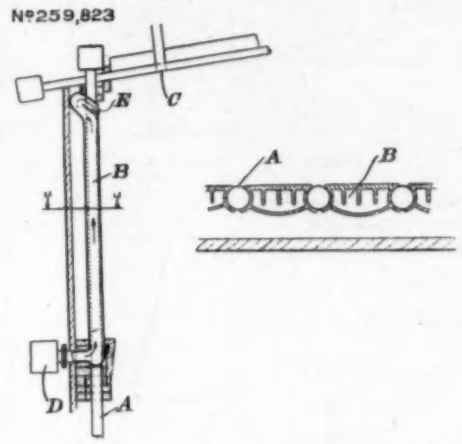


mills, and is especially concerned with the reduction of the final end of the rough material, shown at A in the drawing. The mandrel over which the tube is rolled is shown at B, and it is surrounded by a sleeve C that supports the back end of the tube A. When the rolling has been carried to the extent shown, it is necessary to retract the sleeve to clear the rolls, and this operation is carried out as follows:—The ring D is pushed forward to the position indicated by dotted lines, and then, when the mandrel holder E moves backward, under the action of the rolls, the catches F F are released and the spring G drives the sleeve backward. When the tube has been completely rolled, it is taken off, together with the hot mandrel, a cool mandrel is put in its place, the sleeve is pushed forward, the catches re-set, and the process repeated with another blank.—*October 21st*, 1926.

FURNACES.

259,823. March 12th, 1926.—Combustion Chambers of Furnaces, *Babcock and Wilcox, Ltd., Farringdon-street, London, E.C.* 4.

This invention is primarily concerned with the combustion chambers of furnaces burning powdered coal, and with the cooling of their walls. The cooling is effected by means of water tubes A A and air ducts B B. One of the burners is indicated at C.

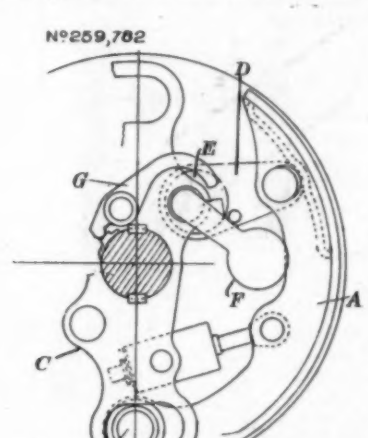


The air ducts, it will be seen, are provided with ribs to increase their effectiveness in cooling the furnace walls, and in heating the air, which is subsequently used to help the combustion of the powdered fuel. The air is supplied to the ducts, at a pressure of about 30 mm. water gauge, from the box D and travels up the ducts at a speed of from 15 m. to 20 m. per second. It escapes into the furnace at E, adjacent to the burner C, and is said to produce a short flame.—*October 21st*, 1926.

MOTOR CARS AND ROAD TRAFFIC.

259,782. November 9th, 1925.—Clutches, W. Hunt, 46, Hamilton-road, Oxford.

This clutch is of the centrifugal type, but is also capable of disengagement manually, regardless of the speed at which it is running. The illustration shows only one-half of the clutch. The shoe A is pivoted at B in a slot in the cage C, and is supported

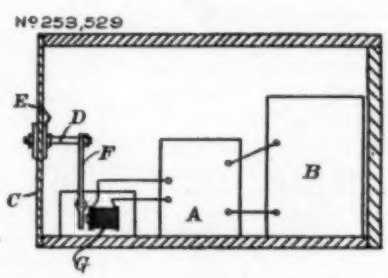


at the other end by the link D, which, in turn, is fixed to the cage C by the eccentric pin E. To this pin there is attached the weighted lever F, which, under the influence of centrifugal force, brings the clutch shoe into action. It can, however, be retracted by means of the rocker G, which is manually operated.—*October 21st*, 1926.

MISCELLANEOUS.

253,529. June 8th, 1926.—Improvements in or relating to Electric-acoustic Systems, *Marconi's Wireless Telegraph Company, Ld., of Marconi House, Strand, London, W.C.* 2.

In general, this invention relates to systems comprising loud-

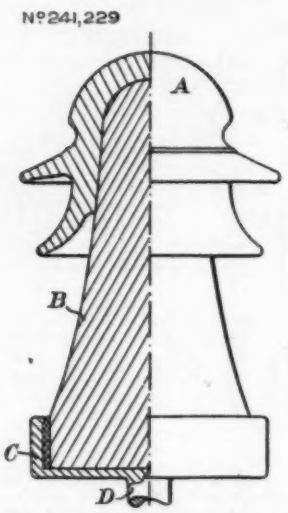


speakers and electric or electro-acoustic devices, such as receiving apparatus or electric phonographs, and the principal object of the invention is to increase the volume of sound from such

systems without distortion and to improve generally the quality of sound output. The cabinet encloses a radio receiver, electric phonograph or similar device, represented by A and B. The side C of the cabinet is constructed so that it can act as a diaphragm. A rod D is fastened to the side C by means of a bolt, a gasket being provided at E. The rod D is also attached to the armature F, which is operated by an electro-magnet G. The coil of this electro-magnet is connected to the output side of the receiving or phonographic device. The changing currents in the coil of the magnet cause the armature to oscillate and the diaphragm C to vibrate. The side of the cabinet is said faithfully to reproduce the sounds corresponding to the current amplitudes in the output circuit of the receiving apparatus.—*October 21st*, 1926.

241,229. October 12th, 1925.—IMPROVEMENTS RELATING TO INSULATORS, Allgemeine Elektricitäts-Gesellschaft, of 2–4, Friedrich Karl-Ufer, Berlin, N.W.

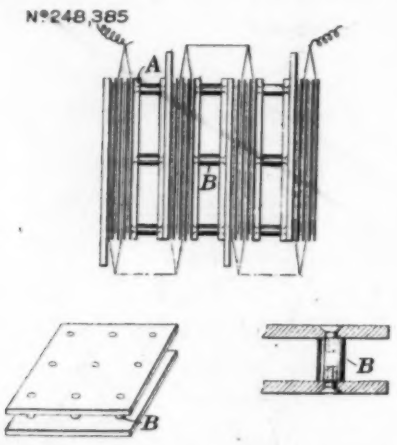
The insulator described in this specification is for high-tension overhead conductors, and is fixed upon the upper end of a bolt or other support. The head A, which carries the conductor, is of



the usual form, and the inner part B is solid, or may be hollow, at the lower part. The three parts, A B C, may be made separately and secured together, or they may be integral. The part C is a metallic conducting socket, provided with a screw-threaded bolt D, which serves for mounting the insulator on its support. The insulator may be of any desired shape.—*October 14th*, 1926.

248,385. February 26th, 1926.—IMPROVEMENTS IN AND RELATING TO ELECTRICAL CONDENSERS, *Dubilier Condenser Company* (1925), *Ltd., of Duncan Works, Victoria-road, North Acton, London, W.* 3.

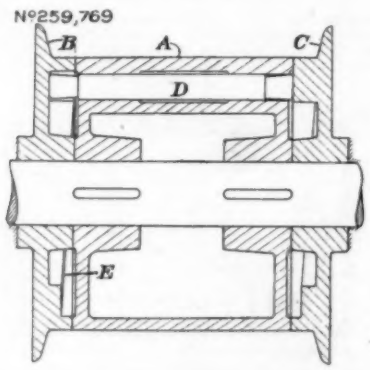
This specification describes an improved electrical condenser, consisting of sections with an improved spacing member through which a cooling medium is made to circulate. The cooling



medium circulates between the sections and through the condenser. One of the objects of the invention is to enable the condenser to be easily assembled and dismantled. The sections of the condenser are arranged in groups, as shown, with intermediate spacers A between them. Each spacer consists of two plates separated by sleeves B.—*October 14th*, 1926.

259,769. October 23rd, 1925.—WINDING DRUMS, W. Reid, R. H. Reid, and W. Reid, jun., Burnbank, Hamilton, Lanark.

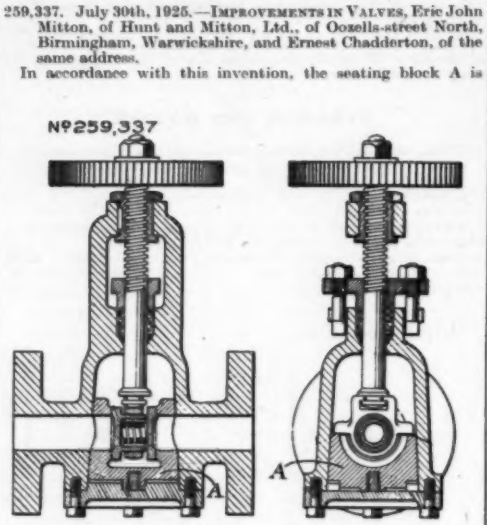
This drum is intended for such purposes as the operation of a



wagon tippler, where two ropes have to be wound in alternately, and avoids the necessity for two separate drums. The drum proper is shown at A, and is keyed to the shaft. There are two loose end pieces B and C, to each of which there is attached one of the ropes. Within the drum there is a sliding bar D, which can engage to drive either one of the end pieces. As shown, it is driving the end B, and that rope will then be wound on to the drum when the shaft is rotated. On reversing the shaft, the rope will be unwound again until the end piece B is arrested by a stop released by the rope. A continuation of the rotation carries round the drum and the bar D slides over the cam face E, so that it engages the end piece C, when the rope attached to that end is hauled in and wound on the drum.—*October 21st*, 1926.

259,337. July 30th, 1925.—IMPROVEMENTS IN VALVES, Eric John Mitton, of Hunt and Mitton, Ltd., of Oozells-street North, Birmingham, Warwickshire, and Ernest Chadderton, of the same address.

In accordance with this invention, the seating block A is



inserted from the underside of the valve body in such a way as to form a fluid tight joint with the valve body, and consequently it is unnecessary to provide a fluid-tight joint between the valve body and the cover. There are three other illustrations.—*October 14th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

DIESEL ENGINE USERS' ASSOCIATION.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Modern Air Compressor Practice in Oil Engine Installations," by Mr. R. L. Quertier. 3.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—Grand Hotel, Birmingham. Annual dinner. 6.30 for 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Sackville-street, Manchester. Paper, "The Sentinel Engine," by Mr. J. W. Beaumont. 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS.—Society of Motor Manufacturers and Traders' Rooms, 83, Pall Mall, London, S.W. 1. Paper, "The Application of Manufacturing Methods to Non-repetition Work," by Mr. H. C. Armitage. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Petrol and its Substitutes for Use in Internal Combustion Engines," by Colonel the Master of Sempill. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Room 14, Temperance Institute, Keighley. Lecture on "Foundry Practice," by Mr. H. R. Shackleton. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. "The Practical Analysis of Merchant Ships Trials and Service Performance," by Dr. E. V. Telfer. 6 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—City Art Gallery, Manchester. President's conversazione.

SOCIETY OF CHEMICAL INDUSTRY: FUEL SECTION.—College of Technology, Sackville-street, Manchester. Conference on Tar. 10 a.m. For programme see page 577.

TUNNELLERS' OLD COMRADES ASSOCIATION.—Gatti's Restaurant, Strand, London, W.C. 2. Annual dinner. 7 for 7.30 p.m.

SATURDAY, NOVEMBER 27TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—City Engineer's Office, City Hall, Cardiff. South Wales District meeting. 3 p.m.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS: ASSOCIATES AND STUDENTS' SECTION.—Wood Memorial Hall, Newcastle-upon-Tyne. Social evening. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Atmospheric Electricity," by Mr. G. C. Simpson. 3 p.m.

MONDAY, NOVEMBER 29TH

BRADFORD ENGINEERING SOCIETY.—The Technical College, Bradford. Lecture, "The Keighley Corporation Waterworks, Sladen Valley," by Mr. M. R. Barnett. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "Crank Shafts," by Mr. S. Robertson. 7 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—Showrooms of the Gas Light and Coke Company, Church-street, Kensington, London, W. Paper, "The Uses of Gas in Industry," by Mr. J. Ennals. 7.30 p.m.

INSTITUTION OF WELDING ENGINEERS.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Thermal Disturbance in Iron and Steel during Welding," by Dr. J. H. Paterson. 8 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C 2. Howard Lecture, "Recent Experiments on the Properties of Steam at High Pressure," by Professor H. L. Callendar. 8 p.m.

TUESDAY, NOVEMBER 30TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Paper, "The Mechanical Parts of Large Winding Engines," by Messrs. P. R. Roberts and A. C. Anderson. 6 p.m.

THE ROYAL INSTITUTION.—21, Albemarle-street, London, W. 1. Lecture, "The Imperfect Crystallisation of Common Things," No. II., by Sir William Bragg. 5.15 p.m.

WEDNESDAY, DECEMBER 1ST.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. Paper, "Some Notes on the Design Details of a High-power Radio Transmitter Using Thermionic Valves," by Messrs. R. V. Hansford and H. Faulkner. 6 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS: GRADUATES' SECTION.—Bolbec Hall, Newcastle-upon-Tyne. Paper, "Icebreakers and their Services," by Mr. G. J. Allan. 7.15 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Torque Converter," by Mr. G. Constantinesco, 8 p.m.

THURSDAY, DECEMBER 2ND.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "An Outline of the Trunking Aspect of Automatic Telephones," by Mr. G. F. Odell. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: NORTH-WESTERN BRANCH.—The Engineers' Club, Manchester. Annual dinner.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Lecture, "Valve Steels," by Mr. P. B. Henshaw. 6.30 p.m.

FRIDAY, DECEMBER 3RD.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. "Industrial Ventilation," introduced by Mr. A. E. Harris. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Presidential address, "The Progress of Marine Engineering," by Engineer Vice-Admiral Sir Robert B. Dixon. 7.30 p.m.

SATURDAY, DECEMBER 4TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Shire Hall, Hertford. South Midland District meeting. 10.45 a.m.

THE ROYAL INSTITUTION.—21, Albemarle-street, London, W. 1. Lecture, "Atmospheric Electricity," by Mr. George C. Simpson. 3 p.m.

MONDAY, DECEMBER 6TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: WESTERN CENTRE.—Merchant Venturers' Technical College, Bristol. Exhibition of films. 6.45 p.m.

TUESDAY, DECEMBER 7TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Progress of Combustion," by Professor W. Morgan. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper by Mr. J. N. H. Tait. 7.15 p.m.

WEDNESDAY, DECEMBER 8TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Discussion on "The Circumstances in which Small Private Electric Generating Stations may have Advantages Over Public Stations," introduced by Mr. A. H. Dykes. 6 p.m.

WEDNESDAY TO FRIDAY, DECEMBER 8TH TO 10TH.

INSTITUTION OF CHEMICAL ENGINEERS.—Science Museum, South Kensington, London, S.W. 7. Conference. For programme see page 580.

THURSDAY, DECEMBER 9TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Co-operative Old Hall, Derby. Derby Graduates' meeting. Exhibition of films. 7.30 p.m.

FRIDAY, DECEMBER 10TH.

INSTITUTION OF WATER ENGINEERS.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Winter general meeting. Papers: "Water Supply Finance," by Mr. A. W. Kenyon; "Recent Developments in the Design and Application of Centrifugal Pumps," by Mr. J. P. Hallam; "Repair Works in Connection with the Belmont Reservoir of the Bolton Corporation," by Mr. J. K. Swales; "The History of an Artesian Bore-hole," by Mr. E. J. Silcock. 10.30 a.m.

SATURDAY, DECEMBER 11TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Vestry Hall, Dawlish. South-Western District meeting. Paper, "Twenty Years in an Urban District," by Mr. S. F. C. Churchward. 2.15 p.m.

MONDAY, DECEMBER 13TH.

RAILWAY CLUB.—25, Tothill-street, London, S.W. 1. Paper, "The Underground Railway," by Mr. W. H. R. Dawson. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

EDWARD G. HERBERT, Ltd., of Atlas Works, Levenshulme, Manchester, informs us that it has appointed W. Crockatt and Sons, Ltd., of 64, Darnley-street, Glasgow, S. 1, to represent it in Scotland. Telegraphic address, "Crockatt, Glasgow." Telephone, South 1340 and 1341.

THE VICTORIA OIL ENGINE COMPANY, of Shipley, asks us to announce that it has purchased the business of the late firm of Walsh and Clark, Ltd., Guiseley, Leeds, makers of the "Victoria" oil and gas engines, and that it has resumed the manufacture of these engines both for refined and crude oils.

WE are advised that Radiation Ltd. has disposed of the industrial section of its furnace business, hitherto carried on at Grappenhall Works, Warrington, together with the business of Brayshaw Furnaces and Tools, Ltd., to Messrs. S. N. and E. R. Brayshaw. Fletcher Russell and Co., Ltd., Warrington, will, however, continue to manufacture and supply dental laboratory and general technical apparatus and appliances, which are its own furnace specialties, and the Davis Furnace Company, Luton, will continue to manufacture and supply its "Revergen" furnace in its various forms. The Brayshaw Company has acquired additional works to deal with its furnace trade. Its milling cutter and small tool products will be manufactured at its Mulberry-street, Manchester, works, as heretofore.